MINING engineering

AUGUST 1959

EY REPORT REAPPRAISAL

Wilfley's "Quick-Change" FEATURES Cut DOWNTIME... MAINTENANCE COSTS

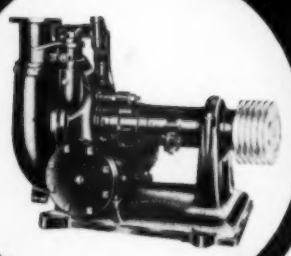
Wilfley parts can be changed in a matter of minutes — and without disturbing the intake or discharge piping. This "quick-change" — another Wilfley exclusive — is an important cost-saving advantage to economy-minded plant operators.

WILFLEY SAND PUMPS

Add to this Wilfley's simplified, packingless design, trouble-free operation, rugged construction, and long life... these are the features that make Wilfley "the" name in sand pumps.

To give you maximum economy in solids pumping every Wilfley installation is JOB ENGINEERED

Write, wire or phone for complete details.



WILFLEY ACID PUMPS
"COMPANIONS IN ECONOMICAL OPERATION"
WILFLEY SAND PUMPS

A. R. WILFLEY and SONS, INC.

DENVER, COLORADO, U. S. A. P.O. BOX 2330

NEW YORK OFFICE: 122 E. 42ND ST., N.Y. CITY 17

COMING EVENTS

Aug. 10-17, annual conference, Autralasian Inst. of Mining and Metallurgy, Melbourne, Victoria, Australia.

Aug. 15, AIME Knoxville Area Subsection, Southeast Section, annual picnic.

Aug. 29, AIME Adirondack Section, field trip to Canadian Titanium Pigment Co., Varennes, Que., Canada; trip with wives, headquarters at Montreal.

Sept. 8, AIME Morenci Subsection, Arizona Section, Longfellow Inn, Morenci, Ariz.

Sept. 13-18, SME Minerals Beneficiation Division, American Chemical Soc. Colloid Chemistry Section, joint meeting on "Solid-Liquid Interphases," Atlantic City, N. J.

Sept. 14-17, American Mining Congress, Metal Mining & Industrial Minerals Convention, Denver.

Sept. 17-18, 7th annual Engineering Management Conference, sponsored by AIME, AIEE, ASCE, AIIE, AIChE, ASME, IRE, Statler-Hilton Hotel, Los Angeles.

Sept. 24-26, SME Industrial Minerals and Coal Divisions, joint meeting, Bedford Springs, Pa.

Sept. 25, 26, AIME Southeast Section, annual fall meeting, Riverside Hotel, Gatlinburg, Tenn.

Sept. 26, AIME Adirondack Section, field trip to Ruberoid Co. asbestos operation, Hyde Park, Vt.

October, AIME Adirondack Section, field trip and football game, vicinity Syracuse, N. Y.

October, AIME Lehigh Valley Section, technical meeting.

Oct. 5-6, ECPD, 27th annual meeting, Wade Park Manor, Cleveland.

Oct. 7-10, Rocky Mountain Assn. of Geologists, 11th annual field conference on Cretaceous sedimentary section in Colorado and adjacent areas; for further information, contact the association, Denver.

Oct. 8-10, Exploration Drilling Symposium, trisponsors: Colorado School of Mines, Pennsylvania State University, and University of Minnesota; Pennsylvania State University, University Park, Pa.

Oct. 12-14, 8th National Clay Conference, sponsored by Clay Minerals Committee, National Academy of Science—National Research Council, University of Oklahoma, Norman, Okla.

Oct. 19-21, Congress, Mining Section, National Safety Council, Congress Hotel, Chicago.

Oct. 27-29, 1959 AIME-ASME Joint Solid Fuels Conference, Netherland-Hilton Hotel, Cincinnati.

Oct. 28-31, International Mining Days and New Mexico Mining Assn., annual meeting, Paso del Norte Hotel, El Paso, Texas

Oct. 30-31, AIME Central Appalachian Section and West Virginia Coal Mining Inst., annual meeting, The Greenbrier, White Sulphur Springs, W. Va.

Nov. 6, AIME Pittsburgh Section and NOHC Pittsburgh Section, 14th annual Off-the-Record Meeting, Penn-Sheraton Hotel, Pittsburgh.

Nov. 9-12, Society of Exploration Geophysicists, annual meeting, Biltmore Hotel, Los Angeles.

Dec. 4, AIME Lehigh Valley Section, ladies' night.

Dec. 5, AIME Knoxville Area Subsection, Southeast Section, annual Christmas Party, C'est Bon Restaurant, Knoxville, Tenn.

Dec. 6, 7, AIME Arizona Section, annual meeting, Speaker: J. L. Gillson; Tucson, Ariz.

Feb. 14-18, 1960, AIME Annual Meeting, Hotel Statler, New York.

Feb. 16-19, Australasian Inst. of Mining and Metallurgy, Symposium on Hydrometallurgy, "Wet Processing of Minerals and Industrial Products," Adelaide, Australia.

May 9-11, American Mining Congress, Coal Convention, Pittsburgh.

July 11-18, 2nd World Conference on Earthquake Engineering, organized by Science Council of Japan in cooperation with Japan Soc. of Civil Engineers, Architectural Inst. of Japan, Seismological Soc. of Japan; Tokyo and Kyoto, Japan.

MINING engineering

Vol. 11 NO. 8 **AUGUST 1959**

COVER *On page 789 of this issue,* MINING ENGINEERING *begins coverage of the recent AIME discussions of the Paley Report. The first of the series is concerned with Paley Report predictions for the iron and steel industries. Artist Herb McClure symbolizes the effect of the constantly shifting balance between supply and demand on this month's cover.*

PALEY REPORT

789 **Iron and Steel: The Paley Report in Retrospect**
• *J. D. Sullivan*

TECHNICAL ARTICLES

797 **Blasthole Mining at Geco** • *G. M. T. Marshall*

803 **Seismic Analysis Aids in Overburden Removal**

805 **Bauxitization in the Pocos de Caldas District, Brazil** • *B. N. Webber*

810 **Ferrograde Concentrates from Arkansas Manganiferous Limestone**
• *M. M. Fine*

813 **Market Trends for Mineral Fillers in Western States**
• *W. F. Dietrich*

817 **Airborne Gravity Meter—Description and Preliminary Results**
• *H. T. Lundberg and J. H. Ratcliffe*

DEPARTMENTS

756 Personnel
762 Mineral Information Section
767 Manufacturers News
768A Free Literature
771 Reporter
821 SME Bulletin Board
830 Around the Sections
834 Personals
841 Obituaries
844 Professional Services
848 Advertisers Index

FEATURED ITEMS

787 **Drift: Ave Atque Sectionem et Miscellanus**
• *J. C. Fox and R. A. Beals*

762 **Mineral Information Section: Books, Abstracts, Manufacturers News, Free Literature**

821 **SME Bulletin Board: Your Guide for Society News**

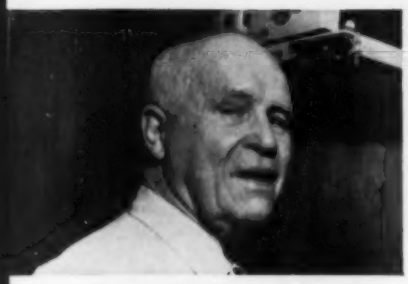
823 **AIME Honors Three Retirees in June**

MINING ENGINEERING Staff, Society of Mining Engineers, and AIME Officers are listed on the *Drift* page.

Address insertion orders and copy to MINING ENGINEERING, 29 W. 39th St., New York 18, N. Y. Send plates to: MINING ENGINEERING, c/o Lew A. Cummings Co. Inc., 215 Canal St., Manchester, N. H. Published monthly by the American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc., 29 W. 39th St., New York 18, N. Y. Telephone: PEnnsylvania 6-9220; TWX NY 1-1304. Subscription $8 per year for non-AIME members in the U. S., & North, South, & Central America; $10 foreign; $6 for AIME members, or $4 additional for members only in combination with a subscription to "Journal of Metals" or "Journal of Petroleum Technology". Single copies, $.75; single copies foreign, $1.00; special issues, $1.50 AIME is not responsible for any statement made or opinion expressed in its publications.

Copyright 1959 by the American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc.

Registered cable address, AIME, New York. Indexed in Engineering Index, Industrial Arts Index, and by National Research Bureau. Second class postage paid at New York, N. Y., and at Manchester, N. H. Number of copies printed of this issue 14,700.



"I've seen our Ford Tandems pull out where others couldn't"

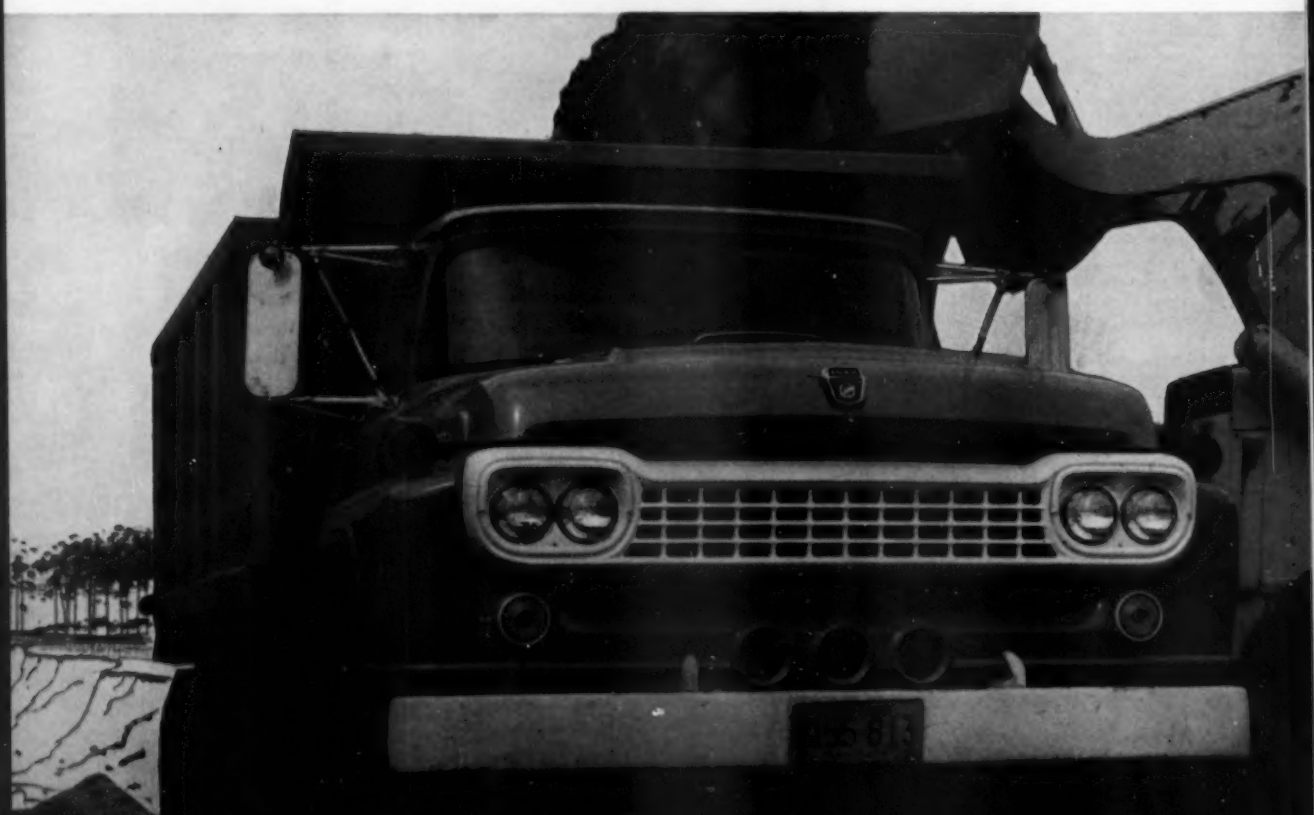
says Walter E. Carlson, President
Park Construction Company, Minneapolis, Minnesota

"We're still using the first Ford Tandems we bought in 1954!

"In the construction business, our trucks really take a beating. They have to be rugged and durable, and that's why we like our Ford Tandems. On one of our earth moving jobs, for example, our Ford T-800's are in constant operation an average of ten hours each day, traveling about two hundred miles. They climb out of the pit, loaded with twelve yards of dirt, and walk right up a 12% grade. In fact, I've often seen our Fords pull out of places where other trucks couldn't.

"My father, who started the business back in 1910 with a horse and wagon, bought one of the first Ford Trucks ever made. That was over 44 years ago—and we've used Ford Trucks ever since. We pioneered the use of Ford Tandem Axle Trucks in this area in 1954. Now we have a total of forty trucks, including thirty-five Fords.

"We completely overhaul our trucks at the end of each construction season. That way we keep them in top operating condition and they last longer. We like Ford service, too, because we don't have to tie up our money in a large parts inventory. We can always get the parts we need quickly from our Ford Dealer."



FORD TRUCKS COST LESS

One day in five... GAS FREE!

Sun.	Mon.	Tues.	Wed.	Thurs.	FREE DAY	Sat.
	1	2	3	4	5	6

LESS TO OWN . . . LESS TO RUN . . .
LAST LONGER, TOO!

'59 FORD PICKUPS GIVE 25.2% MORE MPG!

25.2% advantage delivered in Economy Showdown Tests means five days' driving on four days' gas

The nation's leading automotive research organization* proved and certifies that a '59 Ford Six Pickup will run five days on the same amount of gas the average competitive '59 pickup burns in four days.

The tests were made on 1959 six-cylinder ½-ton pickups of the six leading makes purchased from dealers – just as you would. The trucks were tested in every kind of driving–high and low speeds, open highway and city streets, even simulated door-to-door delivery. And in every test '59 Ford Sixes delivered more miles per gallon than any other make.

Here are the actual percentages:

HOW NEW '59 SIXES RATE IN GAS MILEAGE

'59 FORD SIXES GIVE	25.2% more miles per gallon than Make "C"	31.1% more miles per gallon than Make "I"	9.6% more miles per gallon than Make "G"	42.6% more miles per gallon than Make "D"	22.0% more miles per gallon than Make "S"	25.2% more miles per gallon than the average of all makes

What's the secret of Ford's economy? First, of all pickup sixes, only the Ford Six has modern Short Stroke design which reduces engine friction and thus requires less fuel. Second, to this modern engine, Ford has added a new economy carburetor to meter fuel more precisely in both high- and low-speed ranges.

Your Ford Dealer has the complete report of Economy Showdown U.S.A. See him and get the whole story firsthand.

Go Ford-ward for savings!

**Name available on request.*
Send inquiry to P.O. Box 2687, Detroit 31, Michigan

PERSONNEL

THESE items are listings of the Engineering Societies Personnel Service Inc. This Service, which cooperates with the national societies of Civil; Electrical; Mechanical; Mining, Metallurgical, and Petroleum Engineers, is available to all engineers, members and nonmembers, and is operated on a nonprofit basis. If you are interested in any of these listings, and are not registered, you may apply by letter or resume and mail to the office nearest your place of residence, with the understanding that should you secure a position as a result of these listings you will pay the regular employment fee of 5 pct of the first year's salary if a nonmember, or 4 pct if a member. Also, that you will agree to sign our placement fee agreement which will be mailed to you immediately, by our office, after receiving your application. In sending applications be sure to list the key and job number. When making application for a position, include 8¢ in stamps for forwarding application to the employer and for returning when possible. A weekly bulletin of engineering positions open is available at a subscription rate of $3.50 per quarter or $12 per annum for members, $4.50 per quarter or $14 per annum for nonmembers, payable in advance. Local offices of the Personnel Service are at 8 W. 40th St., **New York 18;** 57 Post St., **San Francisco;** 29 E. Madison St., **Chicago 1.**

MEN AVAILABLE

Ore Dressing Engineer, B.Sc., M.Sc. in mineral preparations engineering, age 33. Eight years experience in coal preparation, adult vocational education, non-metallic beneficiation, and process development. Desires process development. M-488.

Material Engineer, Mineral Economics degree, age 25. Nine months experience; ceramic engineer five weeks; commodity industry analyst, six months; U.S. Army, 23 months. Desires position as quality control engineer, preferably Philadelphia area, but will relocate. M-489.

Engineer-Geologist, B.S.E., M.S., age 32. Eight years experience ground-water development for industrial and municipal water supply, environmental hazards evaluation for nuclear plants. Geophysical and hydraulic testing methods used. Subsurface soil studies, ground-water recharge, design of well fields, interpretation of radiologic monitoring data. Supervisory experience; articulate in speech and writing. M-490.

Metallurgical Engineer; Smelter Metallurgist; Assistant Superintendent; B.A. in education 1941, B.S. in metallurgical engineering 1950, age 40. Nine years experience in production supervision in nonferrous smelting and refining (Cu, Ag, Au, and Bi) including experimentation, testing, instrumentation, training, and electrical precipitation units. Speaks Spanish and French. Prefers Southwest, South, Southeast, Mexico, etc. M-491.

Mine Manager or Superintendent, B.S.E.M., age 55. Experienced large and small scale ferrous and nonferrous mining, exploration and development. Mexican passport; recent Mexican experience. Married, no children. Prefers U.S. but will consider foreign location, M-492.

Mining Engineer, graduate, age 32; seven years experience underground production, engineering, and safety supervision. Speaks Spanish, German, Russian. Private pilot's license. Desires responsible position. Prefers foreign. M-493.

Geologist, B.Sc. in geological engineering, age 29. Three years experience mapping, five years supervising diamond drilling, two years writing and editing geological reports related to hydroelectric developments. Desires responsible position U.S. or Canada where writing ability will be utilized. M-494.

Mining Engineer or Superintendent, B.S. in geological engineering, age 54. Good health; prewar varied mine operation background, both open pit and underground; two years Latin America. Now specializing in applications to the Department of the Interior for lands or loans. Location desired, low elevation, West Coast. M-954-Chicago.

Superintendent—Mining: Age 32, metallurgical engineering, E.M. One year: superintendent in charge of tunnel operation, underground testing of atomic explosions; contractor. Seven years: mine engineer, industrial engineer, plant foreman; copper mine. $800. Any location; home, Nevada. S(M)-1973.

Geologist—Exploration, Development, Soils: age 30. Two years as junior geologist, doing slope recommendations, soils investigations in materials department; hiway. Two years work with topographic computer (military). $550. Prefers southeast Arizona, California, West. Home, southern California, S(M)-1943.

Manager, Superintendent—Mines: age 50, E.M. One year as research manager, in charge of exploring, developing virgin coal reserves for coal mine company. Eleven years as manager and assistant vice president in charge of power generating and coal mining. For six years was mechanical mine engineer, directed production engineering, systems; coal mining. Six years, mine superintendent in charge of hydraulic and dragline operated phosphate mine. $15,000. Prefers Southwest, Mexico, Canada, East. Home, New York, S(M)-1926.

Manager, Superintendent, Geologist—Metal Mining: Age 49, E.M., D.S. in geology. Two years as research manager in charge of mining and milling at a gold mine. Three and a half years consulting engineer doing examinations, reports, evaluation in metal mining. Two and a half years as exploration geologist in metal mining. Eight and a half years as mine superintendent: cement, gold, silver, lead, zinc, copper, mercury, and fluorspar mining. $500. Prefers Mexico, Latin America. Home, Mexico. S(M)-180.

Geologist—Oil, Gas, Mineral: age 54. For 16 years a geologist, oil and gas consultant. Nine years geologist doing exploration and research, geology and geophysics; petroleum products. For six months was a mucker in gold mining. For six months worked on construction of cyanide plant. For two years was assistant geologist for oil & gas company. Salary, open. Any location. Home, San Francisco. S(M)-161.

Mine Manager, Engineer—Mineral Exploration, Development: age 54, M.S. in mining engineering. For twelve years was mine manager, field engineer in gold, tin, tungsten; experienced in operations, exploration, and development. For six years was president and plant manager doing research and development of plastics and adhesives. $12,000. Prefers western U.S. Home, San Francisco East Bay. S(M)-1894.

Chief Engineer, Designer—Mining, Construction: age 36, M.S., C.E., licensed civil engineer. Worked for seven years as assistant chief engineer in operation and design; mining and milling. For four years worked in senior structural design in refineries and chemical plants. For two years was chief engineer in charge of design, construction, maintenance of bridge structures and public works. $13,000. Any location. Home, South America. S(M)-1887.

Geologist, Mine Engineer—Research, Exploration, Operations: age 25, geological engineer. Three years experience in research geology, exploration; surveyed underground, surface, maps; manganese mine. Two years training as miner, underground in base metals. $450. Any location. Home, Montana. S(M)-1874.

Superintendent, Manager—Mining: Age 35, mining engineer, geological engineer. Worked for nine years as mining captain in charge of surface and underground operations on copper; supervised test programs on equipment, ventilation, administration for mining and fabricating company. $8,400. prefers U.S. Home, Michigan. S(M)-1873.

Mining Consultant, Vice President—Ferrous, Nonferrous; age 61, mining engineer, M.S. in metallurgy. Seven years spent as commodity industry analyst, consultant in technical and economic aspects of procurement in storage of critical and strategic minerals, materials; evaluated mining and metallurgical enterprises for the government. Vice president for eight years, consulting engineer; directed, administered mineral properties; industrial and manufacturing firm. One and a half years as vice president of organization, administration, domestic and international air transportation. $12,000. Prefers California, U.S., Europe. Home, D.C. S(M)-1177.

Plant Engineer, Maintenance, Production-Chemical, Mining Petroleum: age 32, M.E. Assistant maintenance superintendent for three years, administering maintenance dept.; planned new contracts; estimated budgets; did field engineering for potash mine and refinery. For three years was plant engineer, liaison between central and field engineering working in design, detail for potash mine and refinery. One and a half years spent in design and detailed equipment, plant; potash. One year spent as chemical plant operator on plant equipment. $9600. Prefers Southwest, Midwest, West. Home, New Mexico. S(M)-1746.

Junior Geological Engineer: age 22, recent graduate in geological engineering. Desires employment and experience in hard rock only. Mining; salary, $425 month. U.S. location. S(M)-1145.

Sales Representative or Superintendent. Experience ranging from foreign sales representative for mining-construction machinery manufacturer to mining property superintendent. Have established new properties complete with facilities and organization. Would make good junior partner in established equipment and machinery business, or foreign sales trouble shooter. Available after 60 days notice. M-495.

(Continued on page 758)

SENIOR RESEARCH METALLURGIST

RHOANGLO MINE SERVICES, LIMITED

A Senior Research Metallurgist is required for research and development work in the field of non-ferrous ore dressing and metal extraction processes of all kinds, with particular reference to copper, cobalt, lead and zinc.

Rhoanglo Mine Services, Limited provides consultant services to the Northern Rhodesian copper companies directed by Anglo American Corporation of South Africa, Limited, and to the Rhodesia Broken Hill Development Company, Limited. Several development projects are conducted simultaneously by staff of approximately 40. Development normally progresses from the laboratory to tonnage scale pilot operation.

Applicants should have approximately ten years experience in applied research and/or operations with an emphasis on Plant and Process development. Only applicants experienced in team leadership will be considered. Executive ability would enhance future prospects.

Location:—Kitwe, Northern Rhodesia has an equable climate and is a modern township with all facilities.

The commencing basic salary would be in the range of £1,800-£2,160 sterling per annum. In addition to basic salary, the position carries a variable cost of living allowance, at present approximately £6 per month and a variable metal bonus which as present is about 25 percent of basic salary. There are generous pension, life assurance and medical benefits, and housing complete with basic heavy furniture is available at a nominal rental. Paid leave, which may be accumulated up to a maximum of three years entitlement, is at the rate of 51 days per annum. Transportation to Northern Rhodesia will be provided for the successful applicant.

Applications stating age, marital status, qualifications and experience, together with a recent photograph and the names of two referees should be addressed to:

The Secretaries, Rhoanglo Mine Services, Limited, P.O. Box 172, Kitwe, Northern Rhodesia.

SENIOR PROJECT ENGINEER—DESIGN

Metallurgical-Chemical Plants

and

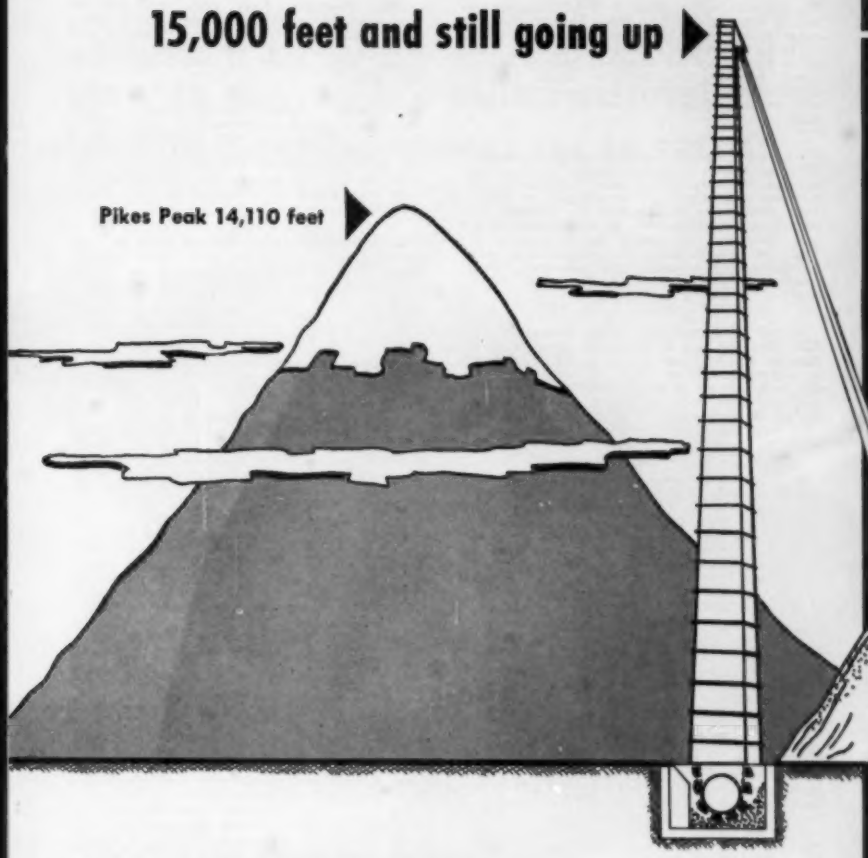
SENIOR POWER PLANT ENGINEER-ESTIMATOR

for permanent positions with one of the world's leading Engineering-Construction Companies. Headquarters in San Francisco.

P.O. Box 8 ME, Mining Engineering, 29 West 39th Street, New York 18, N. Y.

Another PLUS value...

Rated For
RIGHT Selection



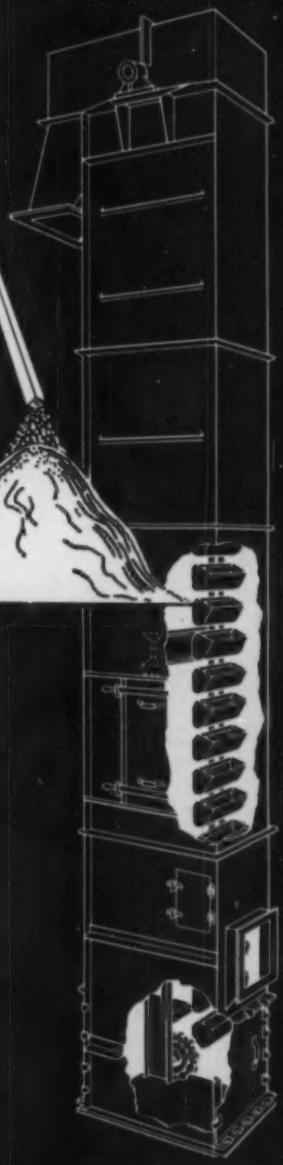
REX CEMENT MILL BUCKET ELEVATORS

Higher than Pikes Peak... that's the total footage of Rex Cement Mill Elevators which have been installed in the past five years. Here's proof of the cost-saving, profit-adding advantages of this advanced concept in elevator design.

Five years ago CHAIN Belt introduced this completely new idea in cement mill elevators... a concept based on the needs of modern cement mill operations. It was radical... the first really new idea in bucket elevators in 20 years. Each component was individually designed and balanced with the strength of the others. The results: increased capacity... longer life... freedom from premature breakdowns... economy.

Today more than 15,000 feet of these new elevators are working in cement mills all over the world... and the total increases daily. The new concept is so sound... so basically right... it has become a standard that others are still seeking to reach. For complete data on Rex Cement Mill Bucket Elevators or Elevator Components, write for Bulletin No. 3304. CHAIN Belt Company, 794 W. Greenfield Ave., Milwaukee 1, Wis. In Canada: CHAIN Belt (Canada) Ltd., 1181 Sheppard Ave. East, Toronto.

REX®
CEMENT MILL
BUCKET ELEVATORS



REX Rated Centrifugal
Discharge Bucket Elevator

Bulletin
No. 3304
gives you complete information on Rex Cement Mill Bucket Elevators—includes tables for fast, easy selection.

Personnel

(Continued from page 756)

Manager, Superintendent, B.S. in mining engineering, age 37. Thirteen years experience mining engineering supervision, and management of open pit mining properties; have directed large new open pit operation through planning, construction, and into production; desire position in management or operations. Prefer U. S. M-496.

Mining Engineer, E.M., D.Sc., age 33. Experienced in teaching, administrative responsibilities, research, industrial development, cost analysis, cost estimating, and design engineering in mineral engineering field. Experienced also in mine development, mine exploration and valuation, underground mining methods, mine production, geological interpretation, and application. Consultant for various mining problems. Desires responsible position in mineral industry. M-497.

Manager, Administrative Assistant, Superintendent, B.S. in mining engineering, age 39. Eighteen years varied mining experience, last six and at present in top management. Energetic, good organizer in establishing new mining operations, strong in personnel, labor and community relations, financial and cost accounting. Fluent Spanish. Location, open. M-498.

POSITIONS OPEN

Mine Engineer or Geologist—Gold: graduate mining engineer or Geologist, preferably single. With at least four years mining experience underground and surface mapping, survey, geological, examining drill cores, design of simple construction work; knowledge of Spanish helpful, but not required. Work as assistant to chief engineer-geologist, layouts for underground advances, stoping, mapping, survey, design simple construction, surface geology mapping, control of claimlines. $500 to $550 U.S. currency per month; furnished house free for married; single, $75 per month for board. Two year contract; with transportation expenses. 2000 tpd. Gold. Central America. S(P)-4310.

Assistant Superintendent—Copper Mill: Must have good experience in mill operations and in working with Spanish-speaking natives, Spanish necessary. For a large copper milling operation. Applications should be complete and by mail. Salary commensurate with experience. Transportation paid. Peru. S(P)-4236a.

Metallurgist—Copper Milling: Must be well qualified by experience and have proven ability to work with Spanish speaking native workers, Spanish necessary. Submit applications by mail. Transportation paid. For a large, well established copper milling operation. Peru. Salary, open. S(P)-2436b.

Assistant Plant Engineer—Heavy Chemical: M.E., Ch.E., or E.M. degrees. Past experience should include maintenance and operation of mineral extraction equipment, such as grinding, crushing, pulverizing, and thickening for chemical processing. Well qualified to assist in maintaining and modifying the equipment in an expanding heavy chemical plant of 40 to 50 persons with 10 or 12 staff. Must have knowledge of chemical process equipment relating to corrosive acids, piping, pumping and control of manufacturing. Salary, to $600. San Francisco East Bay. S(P)-4270.

Applied Research—Metallurgical Processes: M.S., or better, with substantial Ch.E. background. Must be well trained in fundamental sciences and interested in solution of industrial problems. Will assist in applied research and development on improvements to new processes or major improvements in fields of beneficiation, hydrometallurgy and pyrometallurgy. Salary commensurate with training and experience. Western U.S. S(P)-4257.

Mining Manager (a), Mine Foreman (b), Mill Foreman and Metallurgist—Copper, Zinc Mining, and Milling: graduates or equivalent in experience. Must have good records and five to ten years of experience in operating a medium sized underground mine and a two-circuit flotation mill. Salary, commensurate with experience and ability. Arizona. S(P)-4216.

Junior Engineering—Nonmetallic Mining and Processing: E.E. or M.E., preferably married and not out of college for more than five years. Will participate in management training, leading to managerial position with a large nonmetallic mining and processing company. Must be adaptable to life in a small mining community. Apply by letter. Salary, commensurate with experience. Nevada. S(P)-4208-R.

Senior Geophysicist-Mining, M.S. or equivalent, with at least eight years work in mining company to cooperate with geologists in coordinating geophysical program for exploration group of large mining company. Western U. S. Salary, open. S(P)-4453.

Designers—Underground, Open Pit Mine, Min.E. or M.E. One for surface plant design for underground operations and also underground mine design, development and production. One for open pit design and production. Under chief engineer. Salary commensurate with training and experience. Housing available. Wyoming. Apply by letter. S(P)-4431.

Sales Engineer—Iron Ore, graduate in mining or metallurgy, age 30 to 40, with several years practical training plus commercial experience selling or purchasing ores and minerals. Will represent producing mines supplying iron ore to Japan steel companies. Must be married and preferably with family. Salary open, plus free housing and business expenses. Japan. S(P)-4400.

Assayer—Base Metal Concentrates, recent actual working experience in practical analytical assays or ores or concentrates (copper, zinc, molybdenum, chrome, etc.) to isolate foreign or trace quantities and to assay and report prior to, during, and after production for chemical salts processing company. $500-550. Northern California. S-4349.

Mine Superintendent, Assistant Mine Superintendent—Coal, with minimum of five years experience as mine foreman or superintendent or highly mechanized coal mine. Salary open. Apply by letter. Southwest. S(P)-4314(a).

Mine Engineer—Coal, with minimum of five years in responsible engineering position involving design, construction, and planning for coal or other mining operation. Salary open. Apply by letter. Southwest. S(P)-4314(b).

Assistant Superintendent—Copper Mill, must have good experience in mill operations and in working with Spanish-speaking natives; Spanish necessary. For a large copper milling operation. Applications should be complete and by mail. Salary commensurate with experience. Transportation paid. Peru. S(P)-4236a.

Metallurgist—Copper Milling. Must be well qualified by experience and show proven ability to work with Spanish-speaking native workers, Spanish necessary. Submit applications by mail. Transportation paid. For a large, well established copper milling operation. Peru. Salary open. S(P)-4236b.

Applied Research—Metallurgical Processes, M. S. or better with substantial Ch.E. background. Must be well trained in fundamental sciences and interested in solution of industrial problems. Will assist in applied research and development on improvements to new processes or major improvements in fields of beneficiation, hydrometallurgy, and pyrometallurgy. Salary commensurate with training and experience. Western U. S. S(P)-4257.

Junior Engineer—Nonmetallic and Processing, E.E. or M.E., preferably married and not out of college for more than five years. Will participate in management training leading to managerial positions with a large nonmetallic mining and processing company. Must be adaptable to life in a small mining community. Apply by letter. Salary commensurate with experience. Nevada. S(P)-4208-R.

District Representative, graduate engineer, either in chemical, mining or minerals beneficiation, with practical experience in the sand and gravel or allied industries. Will work through distributors in the application and sale of aggregate equipment. Salary good, plus incentive on sales made in territory. Territory, Atlantic States, W7617.

Mining or Metallurgical Engineer for two large phosphate mining operations: a large, triple super-phosphate plant, drying, grinding, and shipping facilities, maintenance shops, etc. Salary: without previous experience, $5400 year to start; for experienced man, to $7800 to start. Location, South. W7569.

Mining Engineer with at least ten years experience in quarrying and mining, preferably in nonmetallics. Must be willing to travel extensively. Headquarters, Pennsylvania. W7554.

Mining Engineer, graduate, with three to five years experience in underground metal mine, to do surveying, etc. Salary, $6000 to $7200 yearly. Location, South. W7295.

Mining Engineer, graduate, with underground experience, to do all engineering work for a deep shaft sinking operation with severe water problems, being sunk with aid of freezing methods. Work will include supervision of contractor drilling 400 ft freeze holes from an underground station and reformation of upper 215 ft of shaft from rectangular section to one with a round section. Modern facilities and good schools available. Married man should report single status until satisfied with conditions. Salary open. Location, Canadian Northwest. W7627.

Mining Engineer, graduate, 30 to 40, with underground experience to do all engineering work for deep shaft sinking operation with severe water problems, being sunk with aid of freezing methods. Including supervision of contractor drilling freeze holes from underground station and reformation of upper 215 ft of the shaft from rectangular section to one with round section. Modern facilities and good schools available. Married man reports single to start. Salary open, Canada. For potash company. S (P)-4459.

Junior Mining Engineer, recent graduate, 21 years or over. Academic background in mining engineering technology, soil hydraulics, methods of ground support, materials, handling, etc. Trained on various jobs, including drafting, routine design, underground surveying, mine layout, production methods. $475-525. For mining, milling, uranium. Southwest. S(P)-4457.

URANIUM-VANADIUM MILLING POSITIONS

Mechanical, Chemical and Extractive Metallurgical Engineers and Chemists with good qualifications and 0 to 6 years of experience to work in Colorado Operations. Send resume and copy of college transcript to:

Union Carbide Nuclear Company
Division of Union Carbide Corporation
Post Office Box 1049
Grand Junction, Colorado

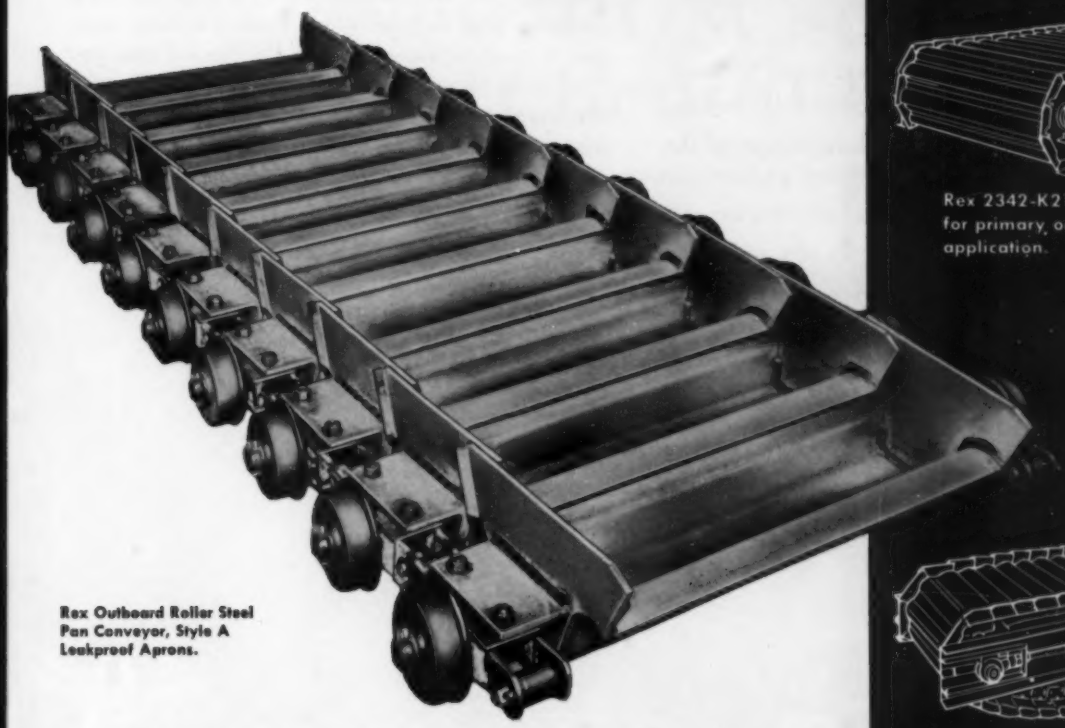
MINING GEOLOGIST. Master degree. Geologic field investigations and preparation of reports. Director, Vernon E. Scheid, Nevada Bureau of Mines, University of Nevada, Reno, Nevada.

TEACHING POSITION. Mineral exploration and applications of geology to mining operations. Master degree. Commercial experience, 5-10 years. Dean Vernon E. Schied, Mackay School of Mines, University of Nevada, Reno, Nevada.

Industrial Mineral Technologist, Master's degree in Mineral Technology, or equivalent. Conduct lab research and field investigations in industrial mineral preparation and utilization. Teach part time.
Mackay School of Mines, University of Nevada, Reno, Nevada.

Another PLUS value...

How to convey hot bulk materials with initial temperatures up to 1900°



Rex Outboard Roller Steel Pan Conveyor, Style A Leakproof Aprons.

Rex Outboard Roller Steel Pan Conveyors provide a practical solution to many unusual conveyor problems.

Unique construction assures longer life—eliminates many replacement costs down through the years—holds down time and maintenance costs to a minimum.

Here are two of the ways improved Rex design gets right to the heart of the heat problem:

1. Chain and rollers are insulated from maximum temperature heat zone.
2. Carbon steel pans, with large pan surfaces, provide maximum heat transfer.

Long wear life, easy maintenance—Ruggedly built for extra stamina, Rex Outboard Roller Steel Pan Conveyors are known for their long, trouble-free service. Wear is confined to heavy outboard rollers; square through rods connecting the chains assure rigidity, equal load distribution; and outboard roller design permits easy servicing without disassembly of chain or conveyor.

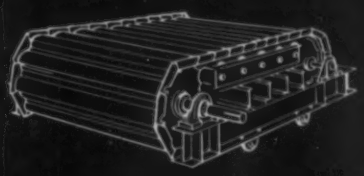
Preferred throughout industry—Deep pan construction, shown above, is ideally suited for use in a wide range of heat processing applications; for example: calcining, sintering, briquetting, beneficiating and nodulizing. This style is available in a wide range of sizes.

Other types available for every service—For information on how Rex Apron Feeders, Apron and Pan Conveyors can help you cut production costs, write CHAIN Belt Company, 4794 W. Greenfield Ave., Milwaukee 1, Wis. In Canada: CHAIN Belt (Canada) Ltd., 1181 Sheppard Ave. East, Toronto.

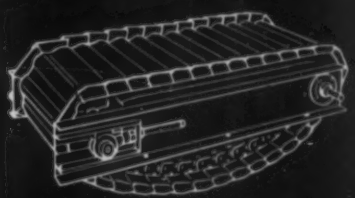
REX®

OUTBOARD ROLLER STEEL PAN CONVEYOR

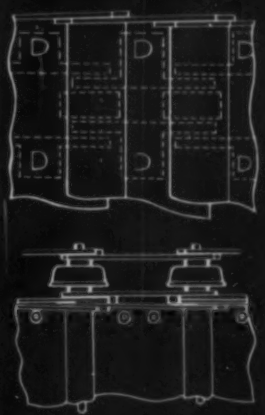
Types For EVERY Service



Rex 2342-K21 Heavy-Duty Feeder for primary or secondary application.



Rex 531-K17 Light-Duty Apron Feeder, used under hoppers and bins to regulate material flow.



Style A aprons with Type K or A chain attachments furnished as machinery parts for many applications.

"when I grow up I'm going to run one of those"

When a fellow daydreams out loud to his best girl, he dreams *big*. Running a big Bucyrus-Erie electric shovel means he's really arrived!

Many a mine or quarry owner who's now "arrived" got his start years ago with Bucyrus-Erie electrics.

That's why two out of every three shovels on the great iron ranges of northern Minnesota and upper Michigan are Bucyrus-Eries. It's also why B-E machines have long been *the standard* in large quarries, in open pit mines, and on the biggest dam and construction projects all over the world. *Wherever important jobs require the best equipment* — that's where you'll see Bucyrus-Erie.

BUCYRUS ERIE®

A-C ALLIS-CHALMERS

metal mining modernization

New ROM screen shakes off brutal battering

Designed to team up with primary crushers to handle toughest jobs in any metal mining flow

There's an Allis-Chalmers screen for every metal mining application

A complete line of inclined screens for scalping, sizing and cyclone plant application; plus the industry's most popular screen — the Low-Head horizontal screen for pre-wetting, washing and sizing, media recovery.

Large volume requirements . . . single pieces of ore weighing as much as four tons . . . such are the demanding conditions under which this screen is setting new performance standards.

Built for heavy-duty service, its husky support frame ignores persistent pounding. Its giant bearings are designed for long life. And even if hundreds of pounds of sticky material cling to its body, this *extra heavy duty* screen still performs efficiently. Vibration isolation is handled effectively by either air springs or steel coil springs.

For complete information, see your Allis-Chalmers representative or write for Bulletin 07B8368, Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin. In Canada, write Canadian Allis-Chalmers Ltd., Box 37, Montreal, Quebec.

Low-Head is an Allis-Chalmers trademark.

ALLIS-CHALMERS

A-5941-MM

Mineral Information

An International Directory of Engineering Source Material

Order directly from the publisher all books listed below except those marked • • • The books so marked (• • •) can be purchased through AIME, usually at a discount. Address Irene K. Sharp, AIME Book Dept., 29 W. 39 St., New York 18, N. Y.

BOOKS

Wage and Salary Administration, by Lawrence C. Lovejoy, *The Ronald Press Co.*, 15 E. 26th St., New York 10, N. Y., 502 pp., $7, 1959—A study of the methods and problems of determining appropriate and equitable rates of compensation. Policy-setting, job establishment, and direct and indirect payment plans are covered. • • •

Clays and Clay Minerals, Proceedings of the Sixth National Conference, *Pergamon Press*, 122 E. 55th St., New York 22, N.Y., 411 pp., $8.50, 1959—Like its predecessors, this volume contains a substantial amount of information on recent advances in clay mineralogy and is a useful reference for clay, ceramics, agronomy, and petroleum engineering. Crystal structure of clay minerals, alteration of feldspars, morpology of clay particles are a few of the items covered. • • •

Gmelins Handbuch Der Anorganischen Chemie, eighth edition, *Verlag Chemie*, Weinheim, Germany, American representative, D. R. Stein, 1074 Washington Ave., Pelham Manor, New York, N. Y.: No. 3, Part 3, *Oxygen*, 818 pp., $67.92; No. 42, *Zirconium*, 448, pp., $63.84; No. 43, *Hafnium*, 43 pp., $5.28, 1958—In the current volumes of this monumental review of chemical and metallurgical literature exhaustive data are given for structure, chemical and physical properties, thermo-dynamic characteristics, and compounds of each element. • • •

Russian Patent Bulletin, *Research Infomation Service*, 40 E. 23 St., New York 10, N. Y.—Each month a translated bulletin of patents published in Russia is available, containing the title and complete text of every chief claim for each newly released patent in the following fields: *Organics*, R-12 o Hydrocarbons, $45; R-12 p Nitrogen Rings, $10; R-12 q Amines etc., $10. *Inorganics*, R-12 i-n, metalloids, etc., $30. *Rubber & Plastics*, R-39 c, synthetic resins, $12; R-38 b, plastic materials, $25. *Fuels* R-10 a-c, coke manufacture, conversion of liquid fuels into solid form, enrichment of fuels etc., $12.50; combination rate for all fields, yearly subscription, $120. • • •

The Chemistry and Physics of Clays and other Ceramic Materials, by Alfred B. Searle and Rex W. Grimshaw, *Interscience Publishers Inc.*, 250 Fifth Ave., New York 1, N. Y., 944 pp., $16.25, 1959—The unbelievable advance of sciences since the last edition of this standard reference work makes necessary the study of a "new" technical science, ceramics, though the history of ceramic materials goes back beyond record. Competitive materials make a new approach to basic principles mandatory. • • •

Technology in American Water Development, by Edward A. Ackerman and George O. G. Löf, *The Johns Hopkins Press*, Baltimore 18, Md., 720 pp., $10, 1959—The results of a three-year staff study, published for Resources for the Future, are divided into four sections: I, The Physical and Economic Environment of Water Development; II, Techniques and Technical Events Significant in the Progress of Water Development; III, Emerging Technology of Potential Impact on Water Use; and IV, Organizational Responses to Problems and Opportunities for Water Development Introduced by Technologic Change. • • •

The Pirotechnia of Vannoccio Biringuccio, translated by Cyril Stanley Smith and Martha Teach Gnudi, *Basic Books Inc.*, 59 Fourth Ave., New York 3, N. Y., $8.50, 1942 edition reissued—This Italian classic of the Sixteenth Century, complete with 84 illustrations, has a new forward by Dr. Smith and reproduces the 1942 design by Carl Rollins. It was published by the Mudd Fund of AIME and now has become part of Basic Book's *Collector's Series in Science*. • • •

Say It In Russian, *Dover Publications Inc.*, 920 Broadway, New York 10, N. Y., 176 pp., 75¢, 1958—A completely rewritten phrase book giving modern expressions, Russian foods and drinks, and many conversational tips for studying or practicing Russian. • • •

Mining Year Book 1959, compiled by Walter E. Skinner, *Walter E. Skinner*, 20 Copthall Ave., London E.C.2, or *Financial Times*, 10 Cannon St., London E.C.4, 820 pp., $7 including postage, 1959—Complete and up-to-date particulars of 950 world mining companies, plus mining engineers and managers, a buyer's guide, world production tables, and advertisements are included in this ambitious volume. • • •

Metal Statistics 1959, *American Metal Market*, 18 Cliff St., New York 38, N. Y., 816 pp., $3.50, 1959—The fifty-second edition of the Little Red Book contains in addition to its regular statistical information on production shipments, exports, imports, prices, consumption, etc. new tables on cadmium and columbium-tantalum, plus tentative specifications for refined secondary lead, and a comparison of mineral output in Russia and the U.S. • • •

Optical Mineralogy, by Paul F. Kerr, *McGraw-Hill Book Co. Inc.* 458 pp., $8.50, 1959—This book explains the use of the polarizing microscope in the study of transparent minerals. The optical properties of common minerals are given and the optical principles are explained. Tables aid identification. It serves as a text for laboratory classes in optical mineralogy and provides a useful reference book whenever the polarizing microscope is employed. This extensive revision of Rogers and Kerr's work covers new data, discoveries, and developments in equipment and techniques which have appeared since the last edition. • • •

Future Energy Sources for Pennsylvania, Mineral Industries Experiment Station Circular 53, by John J. Schanz, Jr., *Dept. of Mineral Economics*, The Pennsylvania State University, University Park, Pa., 178 pp., $3, 1958—Probably the first

energy study at the state level, this work relies on literature already available, plus consultations and contributions from numerous experts in the field. Supply and demand and future potential of state resources are covered.

The Oregon State Library has available a group of 26 volumes of the Transactions that they will distribute gratis to anyone who will reimburse the postage for shipment. The volumes are:

33	1903	64	1920
35	1905	65	1921
38	1907	66	1921
42	1911	67	1922
55	1916	68	1923
56	1916	69	1923
57	1917	70	1924
58	1918	71	1925
59	1918	72	1925
60	1919	73	1926
61	1919	74	1926
62	1920	75	1927
63	1920	76	1928

FOREIGN PUBLICATIONS

CORRECTION

In the April issue, page 368, the prices for Australian publications were quoted in error. The correct prices are as follows:

The Australian Mineral Industry, Quarterly Review, approx. $1.50 annually (12/) or 40¢ per issue (3/).

The Australian Mineral Industry, Annual Review, approx. $1.50 (12/).

Geological Map of Australia, approx. 30¢ (2/6d).

These publications may be ordered from the *Bureau of Mineral Resources*, Childers St., Turner, Canberra City, A.C.T.

Technical Peports, Vol. 3, 1955 from the *Dept. of Mines, New South Wales*, The Under Secretary, G. P. O. Box 48 Sydney, Australia, costs approx. $2.90 (£1.5.9), plus 3/ld. postage.

CANADA

Government Publications

Queen's Printer
Ottawa, Ont.
Canada

Canadian Economic Growth and Development from 1939 to 1955, $1.50.
Certain Aspects of Taxation Relating to Investment in Canada by Non-Residents, $1.
Nova Scotia Coal Industry, 50¢.
Fluorspar, Reference No. 126, Cat. No. FT4-121/2, 50¢.
Some Regional Aspects of Canada's Economic Development, Cat. No. Z1-5535, $4.

Publications Distribution Office
Mines Branch
Dept. of Mines Technical Surveys
Ottawa, Canada

Report No. 858, Water Survey Report No. 9, Churchill River and Mississippi River Drainage Basins in Canada, 50¢.
Report No. 862 The Canadian Mineral Ihdustry 1955, $1.
Research Report R 30 Low Pressure Hydrogenation of Coker Distillate From Athabaska Bitumen Fuels Division, 25¢, 1958.
Research Report R 36 The Measurement of Wall Thickness of Metal from One Side Only, By The Direct Current Conduction Method, 25¢, 1958.
Research Report R 40 Grain Boundaries in Metals, 25¢, 1958.

Manitoba

Dept. of Manitoba
Mines and Natural Resources
Winnipeg, Man., Canada

Geology of the Barlow Lake Area, Granville Lake Mining Division, Publication 57-2, gratis, 1958.

Give the problem to GALIGHER!

Most of the 1400 beneficiation problems assigned to us over the years have been in the "tough" category – many of them problems already written off as infeasible

This challenge to Galigher engineers has covered a wide range of assignments, including initial ore tests, new projects, quality improvement and by-product studies. In every instance, much was at stake and the factual findings of tremendous importance.

It takes seasoned experience, finest technical skills and the ability to coordinate laboratory results with existing field equipment to accomplish the unusual in ore beneficiation.

If you have a problem, give it to Galigher!

GALIGHER
CONSULTATION • ORE TESTING • PLANT DESIGN

Leaders in Experience and Service

M 506

GALIGHER PRODUCTS: AGITAIR® Flotation Machine VACSEAL Pump, Geary-Jennings Sampler Acid-proof Sump Pump, Geary Reagent Feeder Laboratory AGITAIR® Flotation Machine, Laboratory Pressure Filter, Laboratory Ball Mill, Rubber Lined and Covered Products Plastic Fabrication

METALLURGICAL DIVISION . . . ENGINEERING SERVICE

The GALIGHER Co.

HOME OFFICE: 545-585 W 8th South, P O Box 209, Salt Lake City 10, Utah
EASTERN OFFICE: 921 Bergen Ave (Room 922), Jersey City 6 New Jersey

BOOKS

(Continued from page 763)

Newfoundland

Order From:
Dept. of Mines and Resources
Mines Branch
St. John's, Nfld.

Geology of the Newman Sound Map Area, Northeastern Newfoundland, Report No. 12, 50¢, 1958.

Ontario

Order From:
Dept. of Mines
Parliament Bldgs.
Toronto 2, Ont.
Canada

Report on mining practices and conditions in the Elliott Lake uranium area, Part I, 140 pp., $2.
Geological Report on Bristol Township, gratis.
Annual Report of the Dept. of Mines for 1957: Part II, Mining Operations in Ontario; **Part V,** Boston Township and Concessions V and VI of Pacaud township; **Part VI,** Geology of Falconbridge Township. All gratis.
Index Map of the Province, gratis.
Preliminary Geologic Maps of the following townships. Melgund, Revell, Hyndman, Carscallen, Jamieson, Mountjoy, Ogden, Turnbull and Robb, District of Cochrane, 50¢ each.
Aeromagnetic Survey maps of the Sudbury District including the following townships: Louise, Dieppe, Stalin, Goschen, Sale, Caen, Bevin, Eden, and part of the Whitefish Lake Indian Reserve, 50¢ each.

Quebec

Order From:
Dept. of Mines
Hotel Du Gouvernement
Quebec, Canada

P. R. 372, Lake Orford Area, electoral districts of Brome, Shefford, and Sherbrooke.
P. R. 377, Tuttle Lake Area, Saguenay electoral district.
P. R. 373, Gabriel Lake Area (West Half) New Quebec.
P. R. 375, Oak Bay Area, electoral districts of Matapedia and Bonaventure.
P. R. 376, Boucher-Carignan Area, Laviolette electoral district.
P. R. 380, Mount Wright Area, Saguenay electoral district.
P. R. 382, Causapscal Area (East Half), Matapedia electoral district.
G. R. 78, Bourget Area, Chicoutimi and Jonquiere-Kenogami electoral districts.
G. R. 81, Rinfret Area, electoral districts of Abitibi-East and Roberval.
Madeleine River Area, Geological Report 77.

Saskatchewan

Order From:
Dept. of Mineral Resources
Records Branch
Government Administration Bldg.
Regina, Sask.

The Geology of the Deshambault Lake Area (East Half), Saskatchewan, $1, 1958.
Regional Structure Contour Maps, E-1 through E-6, E-8 to E-14, E-54 to E-56, $5 each, 1958.
Central Saskatchewan Sheet, Regional Magnetic Map, $5, 1958.
Airborne Magnetic and Electromagnetic Maps, covering the following areas: Wathaman Lake, Oliver Lake, Perry Lake, Trout Lake, Eulas Lake, McTavish Lake, $1 each, 1958.

AUSTRALIA

South Australia

Order From:
Dept. of Mines
Box 38, Rundle St. P.O.
Adelaide, South Australia

Geological map of Lincoln, 2/6 in Australian currency, approx. 25¢.
Geological map of Coulta, 2/6 in Australian currency, approx. 25¢.
Groundwater Handbook, (12s. 6d.), approx. $1.35.
Geology of the Farina and Lyndhurst Military Sheets, Report of Investigations No. 12, 2s. (approx 22¢).
The Geology of the Quorn Military Sheet, Report of Investigations No. 13, approx. 22¢ (2s.).
Hydrology of the Mount Pleasant-Angaston Area, Report of Investigation No. 14, approx. 22¢ (2s.).
Geological map of Alexandria, approx. 25¢ (2s. 6d.).
Geological Map of Upper Eyre Peninsula, approx. 25¢ (2s. 6d.).

Tasmania

Order From:
Director of Mines
Box 177 E. G. P. O.
Hobart, Tasmania

The Round Mound District, Bulletin No. 45, approx. 55¢ (5s.), 1958.
Limestone in Tasmania, Mineral Resources No. 10, approx. 55¢ (5s.), 1957.
Geological Map of Tasmania, approx. 11¢ (1s).
Mineral Map of Tasmania (New Series), approx. 25¢ (2s.6d.).
Technical Reports No. 1, 1956, approx. 25¢ (2s.).

Victoria

The Australasian Inst. of Mining and Metallurgy
399 Little Collins St.
Melbourne, Victoria, Australia

F. L. Stillwell Anniversary Volume, 1958, approx. $7 (£3. 3.).

Western Australia

Order From:
Geological Survey of Western Australia
Beaufort St.
Perth, Western Australia

Administrative Extract from Mines Dept. of Western Australia, Annual Report, gratis.
The Geology of the Irwin River and Eradu Districts and Surrounding Country, 7/6d, approx. 85¢, 1954.

Finland

Suomen Metalliteollisuusyhdistys
Etelaranta 10, Helsinki, Finland

Suomen Metalliteollisuusyhdistys, illustrated descriptions of products of member industries of The Finnish Metal Industry Assn., 1955, approx. $6 (1000 to 2000 marcs).

France

Revue de Geographie Physique et de Geologie Dynamique, published in French and available from Masson et Cie, 120, Boulevard Saint-Germain, Paris 6e, $8, 1958.
Annuaire des Mines et Metaux Brut, mining and metallurgical companies with production data, 39 rue St.-Dominique, Paris, $2.

Germany

Mineralogische und sedimentpetrographische Uitersuchungen am Kaolinprofil der Bohrung Kick No. 9 bei Schnaittenbach/Opf., Geologica Bavarica Nr. 37, available from Bayerisches Geologisches Landesamt, München 22, Prinzregentenstr. 28, Germany, approx. $2.40 (10 DM), 1958.
Die Einheitliche Gliederung des deutschen Buntsandsteins in der sudlichen Beckenfazies, Heft 24, available from Hessisches Landesamt für Bodenforschung, Weisbaden, Mainzerstrabe 25, Germany, approx. $3.35 (14 DM), 1958.
Jahrbuch des Deutschen Bergbaus, a manual and directory of the mining industry with descriptions of all mines, facilities, and production capacities, published annually by *Verlag Glueckauf* G. m. b. H., Postfach 279, Essen, Germany, approx. $6 (20 DM).

India

Indian Mining Journal, special issue on Methods of Working Coal in India, available from 6/2 Madan Street, Calcutta 13, India, approx. $1.90 (9 Rupees).

New Zealand

Government Printing and Stationery Dept.
Wellington, New Zealand

Mines Statement, 1957, Parliamentary Paper C. 2, approx. $1.15 (6s. 6d.).
Commission of Inquiry into Accident at Westhaven Coal Mine: Report of Jan. 17, 1958, Parliamentary Paper C. 2B, approx. 15¢ (1 s.).
Geology of Rangitikei Valley, Memoir No. 8, approx. $1.70 (9s.6d.). 1958.
Geology of the Eglinton Valley, Southland, Bulletin No. 58, approx. $3.60 (20s.), 1958.
Regional Metamorphosism in South-east Nelson, Bulletin No. 60, approx. $2.25 (12s.6d.), 1958.

Nigeria

Order From:
The Director
Geological Survey Dept.
Kuduna South, N. Nigeria

Geological Map of Nigeria, (12s.6d.), approx. $2.25; 1954.
The Geology of parts of Niger, Zaria and Sokoto Provinces, etc. Bulletin No. 27, approx. $2.70, (15s.).
The Occurrence of Columbite in Nigeria, Occasional Paper No. 9, approx. 25¢, (1s.6d.).

Northern Rhodesia

Northern Rhodesia Chamber of Mines Year Book for 1956, available gratis from The Northern Rhodesia Chamber of Mines, P. O. Box 134, Kitwe, Northern Rhodesia, or American Metal Climax Co., 61 Broadway, New York, N. Y.

Nyasaland

Order From:
Government Printer
P.O. Box 37
Zomba, Africa

The Geology of Mineral Resources of Nyasaland, Bulletin No. 6, revised 1956, (12/6d.), approx. $2.25.
The Geology of the Nkana Coalfield, Karonga District, Bulletin No. 8, (5/-), approx. 90¢, 1957.
The Geology of the Port Herald Area, Bulletin No. 9, approx. $1.85, (10/6d.), 1958
The Geology of Chilwa Island, Memoir No. 1, approx. $2.80, (15/6d.), 1958.
Recent Investigations of the Sumbu-Nkombedzi Coalfield, Chikwawa District, Report No. 1, approx. 45¢, (2/6d.), 1956.
The Geology of Part of the Mzimba and Rumpi Districts, Report No. 2, approx. 45¢, (2s.6d.), 1958.
Annual Report of the Geological Survey of Nyasaland 1957, approx. 90¢ (5/).
The Geology of the Middle Shire Area, Bulletin No. 10, approx. $1.90 (10/6), 1958.

Pakistan

Order From:
Geological Survey of Pakistan
Embassy of Pakistan
2201 R. Street, N.W.
Washington, D.C.

The Mineral Resources of North Western India, Record 1, Vol. 1, pt. 1, approx. $1.05 (5 Rs.).
Annual Report of the Geological Survey of Pakistan: 1947-1949, approx. 42¢ (2 Rs.); **1950,** 42¢ (2 Rs.); **1951,** 45¢ (2 Rs. 3 As.); **1952,** 65¢ (3 Rs.); **1953,** 42¢ (2 Rs.).
Directory of Economic Minerals of Pakistan, revised in 1954, Record 13, Vol. 7, pt. 2, approx. $1.10 (5 Rs. 2 As.).
Shorter Contribution to the Geology of Pakistan, Record 15, Vol. 8, pt. 2, approx. 35¢ (2 Rs. 12 As.).

Philippines

Order From:
Bureau of Mines
Manila, Philippines

Highlights on New Processes Developed for Utilizing Philippine Nickeliferous Ores, Report of Investigation No. 17, approx. $1, (P1 or P2), 1957.

Southern Rhodesia

Order From:
Director, Geological Survey
P.O. Box 8039, Causeway
Salisbury, Southern Rhodesia

The Determination of Southern Rhodesian Economic Minerals, Bulletin 42, approx. 60¢, (3s.6d.).
The Geology of the Country between Belingwe and West Nicholson, Bulletin 43, approx. $3, (16s.9d.), 1956.

Swaziland

Order From:
Director
Geological Survey Dept.
P.O. Box 9, Mbabane
Swaziland, South Africa

Annual Report of the Geological Survey Dept. 1956, approx. 50¢, (3/), 1957.
The Bomvu Ridge Hematite Deposits Crown Mineral Area No. 7, Mbabane District, approx. $2.70 (15/).
Geological Map of Swaziland, No. 288, approx. $1.40, (8/).
Geology of Southern Swaziland, Map No. 293, approx. $1.40 (8/).
The Geology of the Odzi Gold Belt, Bulletin 45, approx. $2.15 (12s.), 1956.
Mineral Map of Southern Rhodesia, fifth edition. approx. 15¢ (1s.), 1956.

Turkey

Bulletin of the Mineral Research and Exploration Inst. of Turkey, biannual publication, Turkish and foreign editions, *Maden Tetkikve Arama Enstitusu,* Ankara, Turkey, approx, 75¢ each (10 Turkish Liras).

Union of South Africa

South African Mining and Engineering Year Book, South African Mining Journal Syndicate, 201-207 Jubilee House, Simmonds St. Johannesburg, approx. $6.50 (£2 5s.).

ABSTRACTS

In This Issue: *The following abstracts of papers in this issue are reproduced for the convenience of members who wish to maintain a reference card file and for the use of librarians and abstracting services. At the end of each abstract is given the proper permanent reference to the paper for bibliography purposes.*

Iron and Steel; The Paley Report in Retrospect by *John D. Sullivan*—A comparison of an interpolation of statistical data on the production of ferrous materials and on the supply of iron and steelmaking raw materials with the actual values in 1957 shows that no gross errors in estimation of trends were made in the Paley Report. Differences are of degree rather than kind. There are ample supplies of iron ore, although the tonnage of pellets from the concentration of taconites and jaspers are larger than predicted. Imports from South America are large. This paper shows also the potential new supplies that may be expected from eastern Canada.

Although the Paley Report was pessimistic about the supply of obsolescent scrap, a recent report shows that the potential supply of obsolescent scrap is currently ample and sufficient for domestic needs and reosonable exports, and that it likely will be until 1975. This 1957 report points out, however, that because of the changing nature of steel production the relative amount of heavy melting scrap may be expected to decrease.

Due to technological developments, the coke supply situation appears more favorable than might be inferred from the Paley report.

Although the report was not too concerned about the supply of additive metals, and while there was a shortage—particularly of nickel—a few years ago, the conclusions made appear to be sound, particularly since new supplies of these metals are becoming available.

Certain technological predictions made in the Paley report are treated in detail and some issue is taken over certain estimates of adoption of certain new processes. The role of some of these methods in the present iron and steel industry is discussed.

With regard to Paley report data on non-American industry, this paper covers the possible effect of the European Coal and Steel Community on the U. S. iron and steel industry, and statistics are given on the six Schuman Plan countries. Russia's role in the world picture is considered briefly. Canada is becoming one of the world's leading producers of iron ore. Production there of pig iron and steel likewise is growing. **Ref.: MINING ENGINEERING, August 1959, p. 789.**

PCA Tries Semi-dome Shapes for Storing Bulk Product by *Edward E. Ives and William L. Payne*—A unique feature of Potash Co. of America's property near Saskatoon, Sask., is the use of semi-dome-shaped buildings for product storage. Four big structures, timber-framed and corrugated-sheet covered are being built, each designed to handle 20,000 cu yd. The relatively small capacity units give flexibility in storing different grades and sizes and permit greater ease in shipping products as market demands change. In other operations the units could be developed and programmed for construction over a period of years to cope with varying storage problems. **Ref.: MINING ENGINEERING, August 1959, p. 796.**

Blasthole Mining at Geco by *G. M. T. Marshall*—Through careful planning the Geco mine has developed from a prospect in virgin country to one of Canada's larger base metal mines in less than four years. High efficiencies have resulted from good fragmentation and use of gravity movement of ore to crusher by the transfer raise system, followed by conveyor movement of ore to the shaft loading pocket. **Ref.: MINING ENGINEERING, August 1959, p. 797.**

Seismic Analysis Aids in Overburden Removal—The mine engineer or operator can determine easily, quickly, and inexpensively when to drill and blast and when to rip overburden for lower costs. By using seismic analysis he can put the right equipment to work for top job efficiency. The method involves use of a refraction seismograph which measures overall consolidation of subsurface materials, including such factors as rock hardness, stratification or lamination, fracturing or jointing, and the degree of weathering or decomposition. The success of numerous seismic analyses conducted by the engineers indicates that expensive and complicated methods of classifying materials for overburden removal are no longer necessary. **Ref.: MINING ENGINEERING, August 1959, p. 803.**

Bauxitization in the Pocos De Caldas District, Brazil by *Benjamin N. Webber* (TP 4805 I)—During World War II the Pocos de Caldas bauxite deposits of Minas Gerais in Brazil yielded some 60,000 tons. Since then they have maintained a small but almost continuous production. Known for many years, the deposits have been reconnoitered by a number of geologists, but no dimensional study has been possible because there have not been enough exposures to show clearly the depth, bedrock, and habit of occurrence. The geologic setting, bauxite types, parent rocks, and age of deposits are covered in the article. Features conditioning bauxitization are discussed. **Ref.: (MINING ENGINEERING, August 1959) AIME Trans., 1959, vol. 214, p. 805.**

Ferrograde Concentrates from Arkansas Manganiferous Limestone by *M. M. Fine* (TP 59B25)—An extensive low-grade occurrence of manganiferous limestone in Arkansas has been studied by the U. S. Bureau of Mines as a possible source of manganese ore. Laboratory research on samples from surface exposures and churn and diamond drill cores developed a beneficiation process comprising tabling, flotation, and leaching applicable to 8 of the 11 samples studied. As a result of these investigations, Arkansas manganiferous limestone is considered a potential source of the ore. The conclusions drawn from the study are guides to examination and treatment of manganiferous limestone. **Ref.: (MINING ENGINEERING, August 1959) AIME Trans., 1959, vol. 214, p. 810.**

Market Trends for Mineral Fillers in Western States by *Waldemar F. Dietrich* (TP 59H89)—Mineral fillers are relatively inert chemically under the conditions of the use but have physical properties that modify those of the materials in which they are incorporated. The mineral filers considered in this article are asbestos, barite, clays, diatomite, crushed limestone, limestone whiting and lime, mica, silica, talc, and soapstone, and pyrophyllite. Overall growth factors, current production and consumption of selected fillers, supply and demand status, and other important data are included. **Ref.: (MINING ENGINEERING, August 1959) AIME Trans., 1959, vol. 214, p. 813.**

Airborne Gravity Meter, Description and Preliminary Results by *Hans T. Lundberg and John H. Ratcliffe* (TP 4815 L)— In airborne gravity surveys effects of acceleration and irregular movements of the aircraft must be balanced out or overcome. The gradient of vertical gravity is recorded, therefore, by using two masses instead of one. General principles are outlined and theoretical considerations explored in the paper. Instrumental details and tests and trials are enumerated before final interpretation, conclusions, and a look at future developments. **Ref.: (MINING ENGINEERING August 1959) AIME Trans., 1959, vol. 214, p. 817.**

SME Meeting Papers: *The following abstracts of papers presented at SME meetings are given for your information. Copies of these papers are available only if followed by a preprint order number. These preprints are obtained on a coupon basis. The coupon books may be purchased from SME headquarters for $5.00 a book (10 coupons) for members of AIME or $10.00 a book for nonmembers. Each coupon, properly filled out, entitles the purchaser to one preprint. Mail completed coupons to Preprints, Society of Mining Engineers, 29 W. 39th St., New York 18, N. Y.*

Professional Education and Practical Training: An Answer to a Dilemma by *Truman H. Kuhn*—As American civilization becomes more complex, certain academic curricular problems have arisen and the solution to them requires a closer relationship between the schools and the various industries. Since professional colleges and universities face the responsibility of anticipating future academic pressures, a brief consideration of engineering trends is given. A basic shift in emphasis has taken place: colleges are emphasizing engineering sciences to a greater degree than skills, and industry has had to assume a responsibility for the latter. Educators at Colorado School of Mines are continuing to look for ways of maintaining and increasing the relationship between the schools and industry. *AIME Colorado Section MBD Meeting, May 1959.*

Anaconda's Bluewater Pilot Mill Employee Training Program by *Dale C. Matthews*—Mill in question was the fourth plant involved in piloting jack pile mine ores before commercially processing by acid leaching. Although the resin-in-pulp or RIP process had not been tested commercially Anaconda was committed to pioneer it commercially and was faced with the necessity of training technicians and hourly employees. The approach to the task was to expedite construction of an on-the-job pilot mill while laboratory training the perspective supervisors in the technique involved. Various stages of this pilot mill program are outlined, as well as the supervisory development program which succeeded the initial project. *AIME Colorado Section MBD Meeting, May 1959.*

Navajo Employee Training Program—Shiprock, New Mexico by *M. N. Shaw*—A formal employe training program has not been initiated because this operation is a relatively small, high cost one with a small labor force. Training has been delegated to the operating supervisory personnel and one of their major functions is to aid hourly operating personnel in the most efficient performance of their duties. Since the operation is located on the Navajo reservation, a major portion of the labor force is recruited from this area and supervisory tasks are complicated by the necessity for bilingual instruction and by differences in outlook and way of life between supervisors and those they must train. The employe training program, by supervisors, has been designed to advance the Navajo laborer as fast as he is capable of being advanced. An ultimate goal of the program is the replacement of retiring supervisory personnel with on-the-job trained employes. *AIME Colorado Section MBD Meeting, May 1959.*

Empolyee Training at Texas-Zinc's Mexican Hat Plant by *K. C. Apland*—Location of this operation in a remote and decolate desert section of the Navajo Indian Reservation has been reflected in the personnel available for the project. Outlined is the formalized training program which takes place on the job during normal working hours. Verbal on-the-spot training is supplemented by written job outlines and training manuals. Follow-up procedures are established on all phases of the program and an inventory is kept of employee skills available. *AIME Colorado Section MBD Meeting, May 1959.*

New Employee Training at Climax, Colorado by *Hugh Matlock*—As a result of "crash" hiring in 1952 and a high proportion of injuries, it was decided that a training program must be instigated in order to improve performance and lower the accident rate. After considerable on-the-job experimentation with training procedures, a formal training program was evolved. This program is twofold, one aspect covering the mill and the other the mine, and there is heavy emphasis upon safety techniques. Until the program has been completed the trainer is responsible for the safety of the new employe assigned to him for training. Results of the indoctrination program indicate that 1) injury experience has steadily improved, 2) labor turnover has decreased, 3) employe reaction to the program has been good, and 4) as the program has developed tests show that employe comprehension has increased. *AIME Colorado Section MBD Meeting, May 1959.*

Instrumentation in the Ambrosia District by *Clyde Osborn*—Instrumentation employed by four or five uranium mills in the Ambrosia Lake district, New Mexico, were studied, since these mills represent the latest thinking in the area of instrumentation and automation. The ore operations in each of the mills were examined and the extent and form of control and indication were investigated. A majority of management personnel felt that instrumentation contributed directly to reduced costs and overall plant efficiency. On the negative side, installation of automatic controlling devices is expensive, many systems need maintenance of a specialized nature, and some mills have found that their systems are spotty in nature, that is they have too much instrumentation in one area and not enough in others. Although there seems to be no question of the desirability of controls, the question that remains to be answered is: will this particlar instrument or control system provide a tangible return on the investment? *AIME Colorado Section MBD Meeting, May 1959.*

EVERYTHING'S BIG ABOUT THE D9

. . . *including economy!*

You don't sacrifice economy for big production when you step up to a Cat D9 Tractor. When you see big loads of pay dirt rolling in front of a D9—those can be the most economical yards in strip mining today!

Arrington Mining Co. has found this out at its open pit iron ore mine at Troy, Alabama. Its D9 with No. 9S Bulldozer economically strips overburden that is up to 25 feet thick.

Besides, partner Tom Arrington says, "The D9 is worth what you pay for it in dependable service—and I find Cat machines have a high resale value."

Many features contribute to the outstanding economy and resale value of the big D9. To name a few: dependable Cat Diesel Engine with new dry-type air cleaners, the exclusive Caterpillar oil clutch, strong main frame and final drives, long-lived, extra-rugged undercarriage, including lifetime lubricated rollers and idlers.

Get all the facts on the mighty D9—and a demonstration on your strip mining operation—from your Caterpillar Dealer.

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

CATERPILLAR

Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

THE D9... BIG IN PRODUCTION, BIG IN ECONOMY

MANUFACTURERS NEWS

NEWS / EQUIPMENT / CATALOGS

Multi-Dump Bucket

Libu Shovel Co. AB has "the only bucket designed to tip its load to left or right as well as forwards." Designed to save a crawler excavator from unnecessary maneuvering

in dumping, the bucket is made in three sizes. The biggest (shown), designed for the Traxcavator No. 977, easily loads big trucks of the Euclid type. **Circle No. 1.**

Blast Recorder

Geotechnical Corp. has developed a practical field instrument, the Blastcorder, which produces an immediate, interpreted record of peak vibrations during blasting. Quarry

and pit operators can use the unit for controlling blasting within safe limits and also for providing records of intensities if litigation should develop. The Blastcorder is self-contained, battery powered, Fiberglas cased, weighs about 20 lb, and measures 6 x 12 x 19 in. Up to three pickups may be used. **Circle No. 2.**

Finger-Tip Shifting

Effortless shifting of Caterpillar DW20 and DW21 tractors is provided by the SynchroTouch transmission control, introduced as optional equipment by *Caterpillar Tractor Co.* Operators can shift up or down instantly—for faster cycling—by merely dialing a desired gear range. Selector is mounted on top of control box and replaces the gear shift lever. **Circle No. 3.**

Improved Skid-Shovels

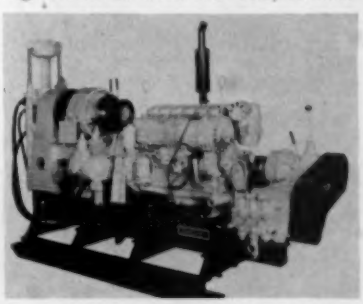
New International Drott TD-9 and TD-6 Four-in-One skid-shovels by *International Harvester Co.* feature new 6-cyl diesel engines, increased track length for greater stability and flotation, and new type roller shells that step up lubricant capacity and permit 500-hr lubrication intervals. **Circle No. 4.**

Rail Train

Easton Car & Construction Co. has developed a 24-gage train for materials handling. Rail tractor and two small trail cars combine to haul 8-ton loads. **Circle No. 5.**

Diamond Core Drill

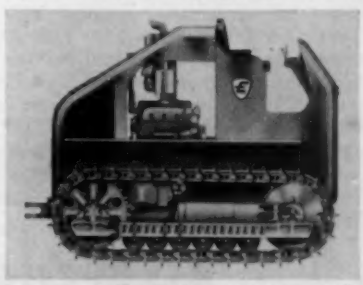
The *Longyear* 44 diamond core drill pictured differs from standard models in that it is equipped with a built-in multispeed drilling pump (at right). The 44 is rated for drilling to 1800 ft with NW rod; to 3000



ft with AW rod. Equipment includes planetary hoist and twin hydraulic swivel head. Drill is powered by a Deutz air-cooled diesel engine, has four forward speeds and one reverse. **Circle No. 6.**

100-Hp Eimco

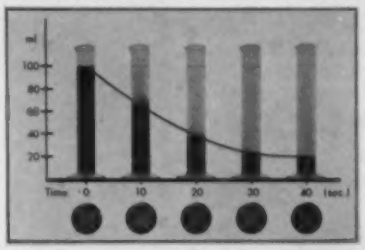
New 103 series tractors by *Eimco Corp.* are 100-hp companions to the bigger and heavier 105s, featuring unitized construction and full hydraulic control of all gears by the flip of a lever at any speed, forward



or reverse. Preliminary specs: 11 ft 6 in. long, 7 ft 9 in. high, and 76 in. wide. **Circle No. 7.**

Flocculant

American Cyanamid Co.'s new Superfloc 16 flocculant is particularly effective in thickening, for stepping up settling rates and overflow clarity. Illustrated here is the



effect of 0.05 lb of the new polymer on a ton of acid-leached uranium ore. Slimes have completely settled in 40 sec. **Circle No. 8.**

Crawler Turbocharger

A miniature turbocharger—weighing just 24 lb—has been developed for use on the new International TD-9 crawler tractor. Fitted on the D-282 6-cyl diesel engine, the 7¾-in. diam turbocharger boosts power output by 23 pct. The device was developed by Garrett Corp. and *International Harvester Co.* **Circle No. 9.**

Ground Prospecting

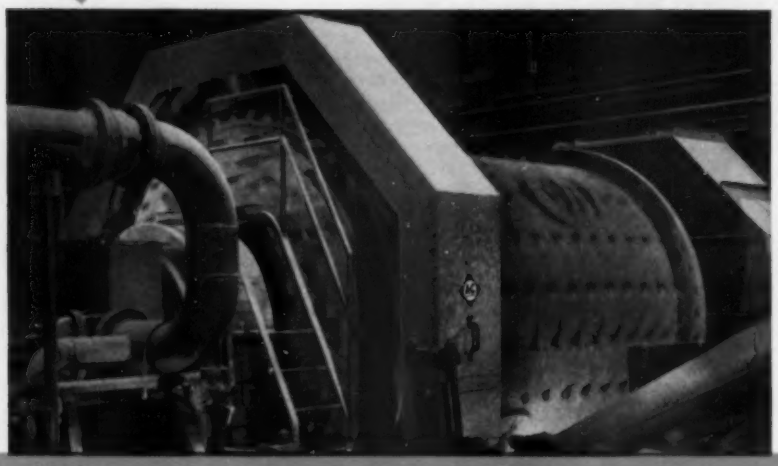
Electromagnetic equipment for ore prospecting on foot is offered in the Turam 2S by *Abem Co.* Each component is compactly designed,

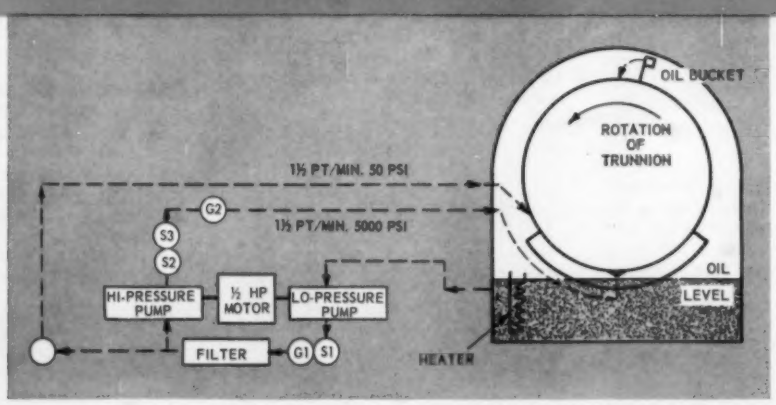
thoroughly tested before delivery, and supplied with a complete set of accessories, tools, and spares. Photo shows compensator-amplifier unit, receiver staffs, generator set. **Circle No. 10.**

Self-Propelled Scraper

A fast, high-production six-wheel self-propelled scraper has been introduced by *LeTourneau-Westinghouse Co.* Named the model C Speedpull, the machine teams a 20-cu yd (heaped) capacity scraper with a 276-hp four-wheel prime mover. Price $43,505 f.o.b. Peoria, Ill. **Circle No. 11.**

metal mining modernization





Floating start, ride and stop for big mills

New Lubritrol system provides constant lubrication for trunnion bearings

Volume producers throughout the metallic mining industry are taking advantage of the cost-cutting, space-saving advantages of big grinding mills. When *you* modernize with a bigger mill insist on Allis-Chalmers — the only mill that gives you the positive protection and maintenance economy of *Lubritrol* constant lubrication. These new and bigger mills actually *float on oil*. No bearing-wearing starts. Less wasted horsepower. All functions of the *Lubritrol* system are automatic . . . controlled by foolproof pressure gages and switches.

There's an expert in your nearby A-C office ready and willing to help. Or drop a line to Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin. In Canada, write Canadian Allis-Chalmers Ltd., Box 37, Montreal, Quebec.

Lubritrol is an Allis-Chalmers trademark.

ALLIS-CHALMERS

A-5934

FREE LITERATURE

(21) SCRAPERS: Use of scrapers and wagons with *Caterpillar Tractor Co.'s* DW20 wheel-type tractor is explained in 8-page booklet "Make the Right Turn." Mechanical steering arrangement includes an hydraulic booster which reduces steering effort yet enables the operator to retain the "feel" of the road.

(22) COAL PREPARATION EQUIPMENT: *Dorr-Oliver Inc.* announces 8-page bulletin 7101 which explains the design, advantages, sizes, and capabilities of D-O units for every operation in the modern plant flowsheet. The equipment is designed for efficient service in a new fine coal preparation plant.

(23) TRACTOR: *Allis-Chalmers Mfg. Co.'s* bulletin MS-1251 covers HD-6 diesel-powered crawler tractors. Graphs and charts give up-to-date information, include accessories and specifications.

(24) WELDING: A comprehensive survey of techniques of welding aluminum using *Air Reduction Sales Co.* Aircomatic and Heliweld processes has been published in 120-page book ADI 1258. The highly specialized aluminum fabrications of today are covered, as well as basic definitions and a brief history of first uses.

(25) ENGINE LOG BOOK: Owners of diesel engines will be interested in the "Engine Log Book" offered by *Caterpillar Tractor Co.* Space for daily entries for 13 months operation permits recording lube oil consumption, parts, service, repairs, etc. Ask for booklet 20167.

(26) ENGINES: The complete line of Caterpillar engines for mining use is described in 8-page bulletin 20169 by *Caterpillar Tractor Co.*, Engine Div. The catalog summarizes the specifications of all current models and includes photos. Engines for industrial use, diesel-electric power plants, and marine applications are shown.

(27) TRUCK OPERATION: Ford Div., *Ford Motor Co.* offers truck owners a subscription to its monthly magazine called "Clues." Informative articles in the May 1959 issue on topics such as hauling coal, wheel alignment, lubricating, Antarctic trucking, and disposing of atomic waste show the advantages of Ford trucks and offer helpful ideas for lowering costs.

(28) MINING EQUIPMENT: *International Harvester Co.* has issued

catalog CR-665-I containing illustrations of skid-shovels, crawler tractors, Payhauler trucks, and engines in action.

(29) CRUSHER: Bulletin 949 from *Jeffrey Mfg. Co.* describes a heavy duty slugger crusher for reducing large size rock and mine refuse.

(30) CONTROL SYSTEM: A new mine fan and circuit breaker monitoring and control system is fully explained in bulletin 5902 from *Femco Inc.* It provides automatic shut-off for all mine power in event of ventilation system failure.

(31) JAW CRUSHERS: Series 10 crushers for gravel and secondary crushing are covered in bulletin BM-10 from *Gruendler Crusher & Pulverizer Co.* Precision machined eccentric shaft, hydraulic adjustment, and welded or cast steel base are a few of the features of the series. Specifications, charts and drawings are included.

(32) COAL RECOVERY DRILLS: Eight-page bulletin ST-59 from *Salem Tool Co.* describes model 1400 and 1500 coal recovery drills. Units, capable of handling augers from 24 to 42 in. are recovering as much as 200 tons of coal per man-shift.

(33) ENGINES: The *Allis-Chalmers* G-149 engine boasts increased life for lower operating cost. Special features include flywheel housing, power take-off, choice of correct carburetion for gasoline, distillate, LPG, or natural gas fuels, and choice of magneto or 12-v distributor ignition.

(34) REAR DUMP: Euclid Div. of *General Motors Corp.* offers 8-page catalog 151R4 on the model R-10 rear dump of 10-ton payload capacity. Hauler, smallest in the Euclid line of off-highway rear dumps, incorporates many improvements over earlier models and can be supplied with standard or quarry body.

(35) JAW CRUSHERS: Cedarapids overhead eccentric jaw crushers from *Iowa Mfg. Co.* are illustrated in bulletin JC-1 with diagrams, drawings, and specifications. The overhead eccentric shaft and angle of the toggle are engineered to assure greatest crushing capacity.

(36) TRACTOR: Improved features of DW21 series G tractor and 470 series B scraper are outlined in 8-page form D915 by *Caterpillar Tractor Co.* A boost to 345 hp, a 99.8-pct efficient dry type air cleaner, and increased scraper capacity are a few of the features.

mail this post card for more information

8

Mining Engineering **29 West 39th St.** **New York 18, N. Y.**

Not good after Nov. 15, 1959—if mailed in U. S. or Canada

Please send { More Information ☐ / Price Data ☐ / Free Literature ☐ } on items circled.

Name_____ Title_____

Company_____

Street_____

City and Zone_____ State_____

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64						

Students should write direct to manufacturer.

(37) BLASTING AIDS: Three new aids to efficient blasting offered by *Atlas Powder Co.* are designed to be used right on the job. The hip pocket blasting cost chart supplements the file-size chart introduced last year. Quick, orderly cost records can be made while drilling, loading, and shooting a blast. A companion piece, the hip pocket loading chart, provides the same on-the-spot record of blast loading pattern. On one postcard size chart there is space for all data of burden, spacing, powder, stemming, and detonators for a blast of up to 20 drill holes. The third piece, a blast summary card supplies a handy general record of each blast.

(38) PREPARATION SCREENS: Wedge-Wire Kleenslot preparation screens for dewatering, screening, washing, extracting, filtering, or sizing operations are described in catalog 103 from *Wedge-Wire Corp.* This 16-page booklet is complete with photos, diagrams, specifications, and features of several units.

(39) LOADERS & BACKHOES: How International Wagner loaders and backhoes are matched with utility tractors to fit exact job needs is graphically described in catalog CR-1076-I by *International Harvester Co.* Special attention is given to the powerful 95 and 65 backhoes built for sustained, trouble-free performance with heavy-gage box-frame booms with a full 180° arc of swing.

(40) WATER TREATMENT: A new bulletin describing a complete line of water treatment equipment has been issued by Process Engineers Inc., div. of *Eimco Corp.* Bulletin SM-1013 features the reactor-clarifier which combines coagulation and flocculation, sedimentation and sludge removal in a single unit. Flash mixers and contactors are also explained.

(41) DIPPER TOOTH: *American Brake Shoe Co.*, American Manganese Steel Div., covers the Simplex 2-part dipper tooth in a 16-page catalog listing over 400 tooth point and tooth adapter models to suit every make of shovel, dipper, and backhoe.

(42) DRYERS: *Standard Steel Corp.* has a bulletin on dryers, kilns, coolers, and other heavy rotary processing equipment for the chemical, mining, and allied industries. Installation photos, interior views of rotary dryers, and thorough descriptions are included in the 28 pages.

(43) DRAGSCRAPER METHOD: A new Sauerman Field Report shows how to extend dragline range and handle difficult jobs. Line drawings of dragline-cranes equipped with Sauerman Crescent Dragscrapers are shown in a variety of long range excavation work. Field report 213 is available from *Sauerman Bros. Inc.*

(44) TABLES AND FORMULAS: "Convenient Tables and Formulas" has been published by *Westinghouse Electric Corp.* and includes 120 pages summarizing electrical data, properties of materials, heat transfer and steam information, measurements, and other subjects.

(45) LUBRICANTS: *Gulf Oil Corp.* has published a booklet to familiarize the mining men with a new line of greases and oils. Gulf Mining Lubricant H. D. is featured for continuous mining equipment. It is a semi-fluid lubricant with superior resistance to water, extreme pressures, and high temperatures.

(46) MINING TOOLS: A revised catalog on Carmet carbide mining tools which includes information on the JR-3 style cutter bit is now being distributed by *Allegheny Ludlum Steel Corp.* It contains 20 pages with photographs of coal drill and roof drill bits.

(47) FORGED-TRAKS: *Athey Products Corp.* has prepared a 12-page booklet on Forged-Traks demonstrating their ability to operate where rubber-tired equipment cannot travel. Low center of gravity provides stability, eliminates sideslip. Pictures show advantages in construction, oil fields, and mining.

(48) DUMP TRUCKS: Modern hydraulic hoists, steel and aluminum dump bodies, and dump trailers specially designed to handle maximum legal payloads and provide longer equipment life are featured in a booklet from *Galion Allsteel Body Co.* Hydraulic hoists included are double lift-arm models, single and twin-cylinder conversion, front-mount and underbody type telescopic units in a wide range of lifting capacities.

(49) COLLOIDS: Technical data from *Burtonite Co.* cover water-soluble colloids which are highly polmerized saccharide complexes of two sugars, mannose and galactose. Supplied as —100-mesh solids, free flowing, they are readily dispersed in cold water under brisk agitation. They are insoluble in oils, organic and mineral solvents, and borated water. About 65 pct of normal viscosity develops, without the aid of heat, within 45 min.

(50) ECONOMIC REPORT: "The Manvers Central Coal Preparation Plant," bulletin M4-B100, is an economic report on the recovery of coal fines by froth flotation as well as the complete processing of all coal received at this 1320-tph plant. *Denver Eqpt. Co.* offers this important data.

(51) EXCAVATOR: The P&H 1-cu yd capacity model 455C crawler excavator is detailed in a folder from *Harnischfeger Corp.* Completely sealed power box, anti-friction bearings, independent propel and swing for faster work, all-welded construction, and triple safe planetary boom hoist are some of the special features.

(52) DIALYSIS: A comprehensive technical article on the theoretical and practical aspects of dialysis is now available from *Graver Water Conditioning Co.* Technical reprint T-174 covers basic equations involved in dialysis separation, type and design of dialysis membranes and equipment, and industrial applications possible with Graver's Hi-Sep Dialyzer.

(53) WEIGHING SYSTEMS: Bulletin 2M just published by *Trans-Weigh Co.* shows a complete line of equipment for automatic process weighing and control, plus inventory weighing. Belt-Meter controls the flow of belt-conveyed solids. A new continuous integrator gives high precision inventory weighing.

FIRST CLASS
PERMIT No. 6433
New York, N. Y.

BUSINESS REPLY MAIL
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

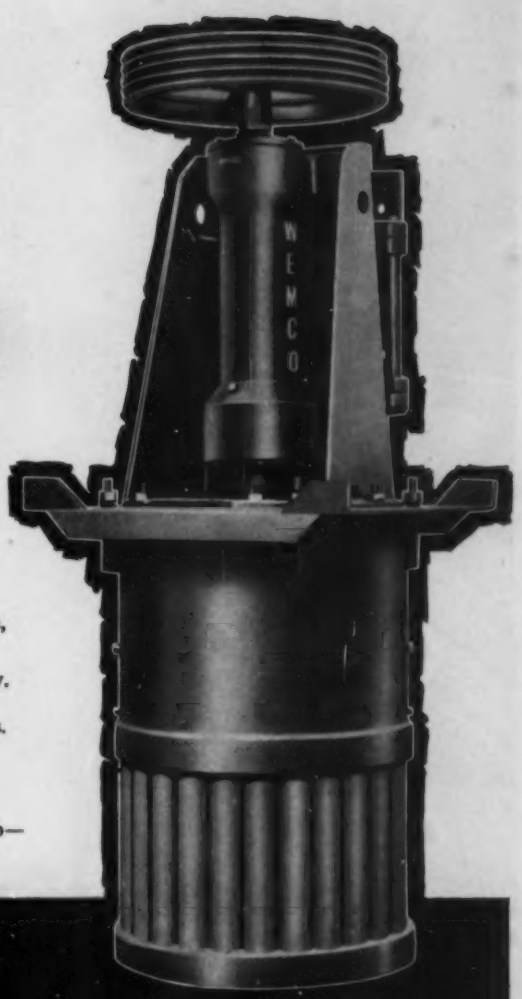
—POSTAGE WILL BE PAID BY—

MINING ENGINEERING

29 WEST 39th STREET

NEW YORK 18, N. Y.

THIS DECISION WILL PAY BONUS PROFITS OF MORE THAN $6,500 EVERY DAY!



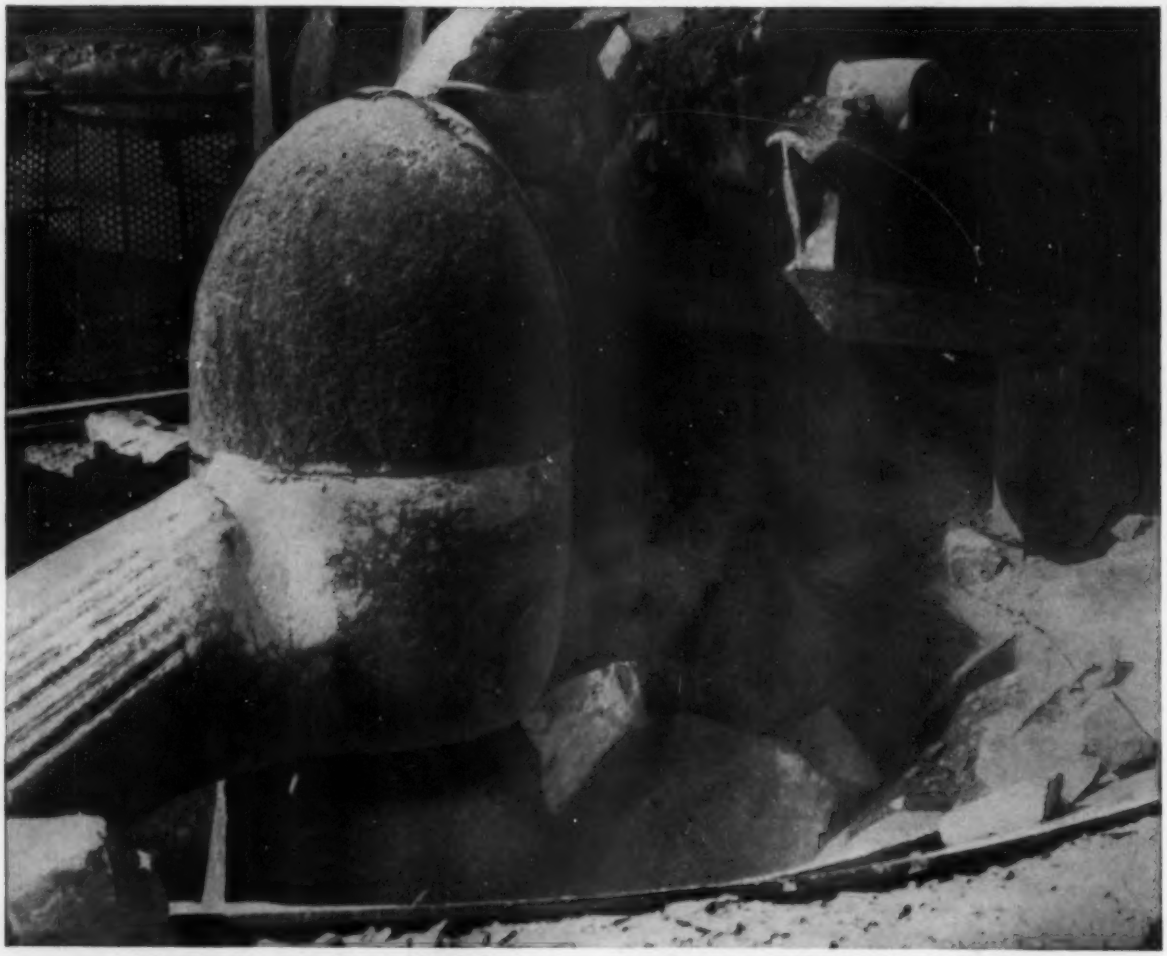
This order and installation of Wemco-Fagergren Flotation Machines by a leading coal producer will result in additional profits of over *$6500 per working day*— and for surprisingly low capital investment. Cost of the total plant addition, including the flotation cells, will be offset in less than four months.

This is another example of how Fags go to work—profitably. Recovery is consistently higher; floor space, maintenance and operating labor, reagent and other requirements are less.

The Wemco-Fagergren record of profit-producing installations tells the story of sound experience. The men of Wemco will be glad to furnish all the facts and discuss why Wemco-Fagergren Flotation will do a better job—where flotation has a place.

WEMCO®

a division of
Western Machinery Company, 650 Fifth St., San Francisco, Calif.
and throughout the world



Crushers like this — fitted with Ni-Hard concaves — are turning in impressive service records at Spencer Quarries, S. D. They crush Sioux Quartzite, which, like Taconite, is among the hardest known minerals . . . and it has a compressive strength of over 100,000 psi.

NI-HARD crusher concaves outlast manganese steel 3 to 1

At Spencer Quarries, Spencer, South Dakota, Ni-Hard* concaves in 6-inch crushers, have lasted three times longer than manganese steel rings in the throat area, where compression forces are highest.

In a 30-inch gyratory crusher at Spencer, Ni-Hard bottom ring concaves are in their third year of service—where previously the best manganese steel rings wore out in six months. All of Spencer's Ni-Hard concaves were supplied by Brom Machine and Foundry Co., Winona, Minn.

Whether crushing quartzite at Spencer or working tough Taconite on the Mesabi Range, economical Ni-Hard nickel-chromium cast iron is proving better able to resist abrasion and high compression forces than any other material.

Ni-Hard concaves are available from authorized producers throughout the country. For the address of the one nearest you, write to Inco.

*Registered trademark

THE INTERNATIONAL NICKEL COMPANY, INC.

67 Wall St. INCO New York 5, N.Y.

Looking down the throat of a gyratory crusher. Concaves in the important lower ring are of long-lasting Ni-Hard.

NI-HARD

NICKEL MAKES ALLOYS PERFORM BETTER LONGER

MINING engineering REPORTER

Aid for African Manganese Project

A loan equivalent to $35 million was advanced by the World Bank to Comilog to aid in the development of high grade manganese deposits in the Gabon Republic of Africa. The amount will help finance a 45-mile cableway and a 180-mile rail line as well as mining equipment and services. The Comilog deposits, covering four plateaus in the interior of the Republic, are expected to yield a total of almost 9 million tons of ore. Total cost of the project is estimated at about $89 million.

Sulfur Operation Starts in Mexico

Texas International Sulphur Co. has begun turning out 9000 tons of sulfur monthly at Mexican operations near Minitatlan, Veracruz. The company spent four years in exploration and development.

National Gypsum to Spend $125 Million

National Gypsum Co. announces it plans to spend $125 million on expansions over the next five years. Sales are to be expanded to include all of North America. Three new gypsum plants will be erected, one in California and two to serve major Canadian markets. Cement and paper operations are to be enlarged. Expanded existing production facilities for lime, ceramic tile, and asbestos are included in a broad program.

Canadian Producer Tries Zinc Fabricating

Consolidated Mining & Smelting, Canada's top mine producer of lead and zinc, has purchased National Hardware Specialties, a producer of zinc die castings for hardware and motor vehicles and so enters the zinc-fabricating field for the first time. Company hopes to expand market for Canadian die castings and will also use the National Hardware plant for developing new base metal product uses.

South African Rail Improvement Program Accelerated

The Government of South Africa hopes to improve railway systems in the Union sufficiently to enable the lines to handle all freight offered by 1962—completion is thus scheduled four years in advance of prior plans. Improvements include upgrading 410 miles of line, electrification of 640 miles of track, and building of 160 miles of branch lines. The Government also plans to buy more than 500 locomotives and large quantities of rolling stock.

Skips Replace Truck Haulage at Liberty Pit

Kennecott Copper Corp. has installed twin 25-ton capacity skips in the Liberty pit west of Ely, Nev., replacing truck haulage to the crest. Working three shifts the company will draw out 21,000 tons of ore daily using the new system.

MINING engineering REPORTER

Seawater Magnesia Plant Readied

Michigan Chemical Corp. has announced the start-up of its new magnesium oxide plant at Port St. Joe, Fla. After in-process build-up, finished products will begin moving to consumers in October.

New Alloys Are "Lead-Cemented"

By combining molten lead with a number of other materials, usually metals, researchers at Battelle Memorial Institute have come up with a promising new class of metallic materials. Combining lead and finely-divided boron, for instance, would produce a superior radiation shield for stopping gamma rays (a property of lead) and stopping neutrons (a property of boron). Investigators found that at least six metals are particularly well suited to making new alloys: cobalt, copper, iron, molybdenum, nickel, and tungsten.

Aluminum Giants Team to Form New Fabricator

Aluminum Co. of America and Britain's Imperial Chemical Industries Ltd. have announced plans for establishing a new aluminum fabricator, Imperial Aluminum Co. Ltd. Holdings are to be divided, with Imperial Chemical taking 51 pct and Alcoa 49 pct. The new company, expected to start operating by August 1, will operate a rolling mill and extrusion plant owned by Imperial Chemical in South Wales. Alcoa had previously attempted to acquire an interest in British Aluminum Ltd. but lost out to the combined firms of Tube Investments Ltd. and Reynolds Metals Co.

Alcoa Takes Jamaica Bauxite Option

Aluminum Co. of America and Caribex Ltd., a subsidiary of American Metal Climax, have joined forces for prospecting the bauxite-rich lands of Jamaica. The companies will spend about $200,000 by next May 31 in exploring near Kingston and, if results are good, will be able to lease the land for development under the same provisions the Jamaican Government has granted other aluminum producers in the area.

Reynolds' Massena Plant on Stream

The first of three projected aluminum potlines is now producing metal at Reynolds Metals Co.'s new reduction plant at Massena, N. Y. The new line adds some 33,000 tons to the annual primary reduction capacity of the company.

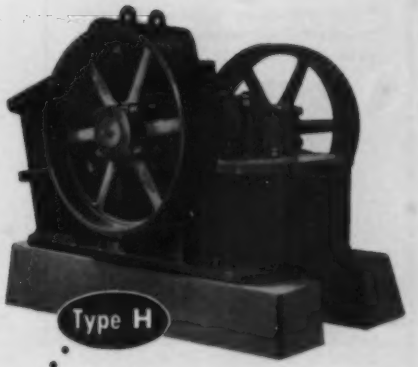
Susquehanna Will Buy Uranium Ore From Vitro

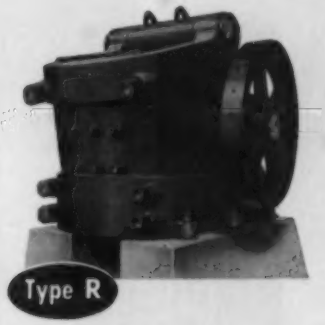
Susquehanna-Western Inc. and Vitro Minerals Corp. have announced jointly that Susquehanna will buy uranium ore from the Vitro mines in the Gas Hills area of Wyoming. Susquehanna plans to process the ore at its new mill at Riverton, Wyo., and expand capacity of the 550-tpd facility in the near future. The contract calls for yearly delivery of ore containing 480,000 lb of uranium and the total purchases may amount to more than $15 million. For Vitro this means mining at the rate of more than 100,000 tons of ore a year at the present grade of the deposits.

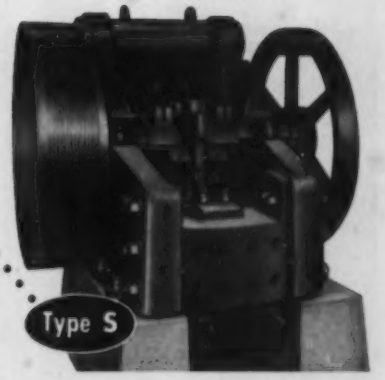
Many operators throughout the world know the economy and rugged dependability of Traylor-Made Jaw Crushers. Over 50 years of experience results in many advantages for the user of these crushers.

Traylor-made Jaw Crushers

Some of the features incorporated in Traylor Jaw Crushers are jaw plates of the Traylor curved type—the pitman shaft is made of annealed open hearth forged steel. The swing jaw is made of cast steel of extra heavy design for maximum strength. For more of the features of Traylor Jaw Crushers, write to Traylor today.







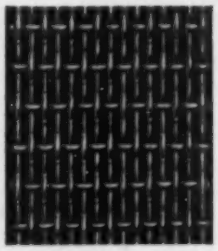
TRAYLOR ENGINEERING & MANUFACTURING COMPANY

1183 MILL ST., ALLENTOWN, PA.

Sales Offices: New York — Chicago — San Francisco

Canadian Mfr.: Canadian Vickers, Ltd., Montreal, P.Q.

When you order screens, be sure to specify the type which best meets your requirements. For example:



For maximum through capacity, CF&I Space Screens with rectangular openings are recommended. The high percentage of open area provides considerable freedom from blinding or clogging.

For maximum freedom from blinding or clogging, CF&I Long Slot Space Screens are the most efficient construction. Because of the open area and intense vibration of wires on the long sides of the openings, material can not cling or build up.

* * *

Whatever your screening operation, our engineers will be glad to help you select the optimum screen for your needs.

The Image of CF&I offers

SPACE SCREENS

for less downtime . . . long screen life . . . accurate screening

Symbol for the dependability of all CF&I steel products, the giant steelman can be relied on for tough, precision space screens.

CF&I Space Screens are ideal for rugged screening operations because they are made from quality steel, and are available in a wide selection of types, weaves, crimps and edge preparations. They give long service and, consequently, fewer work stoppages and greater tonnage output for your screen dollars. CF&I Space Screens are tightly woven to retain uniform spacing and openings, thus assuring accuracy under the most demanding screening conditions.

For engineering assistance in choosing the right space screen for your operation, contact our nearest sales office.

CF&I SPACE SCREENS

THE COLORADO FUEL AND IRON CORPORATION

CF&I STEEL

In the West: **THE COLORADO FUEL AND IRON CORPORATION**—Albuquerque • Amarillo • Billings • Boise • Butte Denver • El Paso • Farmington (N. M.) • Ft. Worth • Houston • Lincoln • Los Angeles • Oakland • Oklahoma City Phoenix • Portland • Pueblo • Salt Lake City • San Francisco • San Leandro • Seattle • Spokane • Wichita

In the East: **WICKWIRE SPENCER STEEL DIVISION**—Atlanta • Boston • Buffalo • Chicago • Detroit • New Orleans New York • Philadelphia

CF&I OFFICE IN CANADA: Montreal

CANADIAN REPRESENTATIVES AT: Calgary • Edmonton • Vancouver • Winnipeg 6924-D

The Inquiring Mind at Oldsmobile

no. 8 OF A SERIES

THE SOUND . . . AND THE JURY

The quiet, solid feeling inside the 1959 Oldsmobile results from patient testing by a highly specialized "jury"—experts in the field of sound analysis.

Unlike most other phases of automotive engineering, there are no instruments which measure the "annoyance" factor of sounds inside an automobile. Subjective, personal evaluation known as the "jury system" is the most important means of determining how quiet it is inside an Oldsmobile.

With the "jury system", several experienced engineers assemble in an acoustically treated room and listen to binaural tape recordings made inside a test car. Careful editing of the tape recording allows rapid side-by-side comparison between two different test conditions and eliminates reliance on memory since considerable time may elapse between actual tests. By pushing a button, each engineer casts a secret "vote" and then the tabulation of the results determines which test condition is superior.

For the greatest possible accuracy, considerable care is taken making the recordings. Special microphones are placed at points corresponding to the passengers' ears. The recording equipment is in a specially equipped vehicle which follows the test car over a "ride road" that is carefully constructed to excite the vibrations and sounds that occur under normal driving conditions.

Quality, like quietness, is not accidental. It is the deliberate effort by Oldsmobile engineers to *design* quality into every automobile they produce. You'll like the 1959 Oldsmobile—with its solid Body by Fisher—it's the quietest car built! Experience this quality for yourself by visiting your local Authorized Oldsmobile Quality Dealer as soon as possible.

OLDSMOBILE DIVISION
GENERAL MOTORS CORPORATION

OLDSMOBILE **Where Quality is Standard Equipment!**

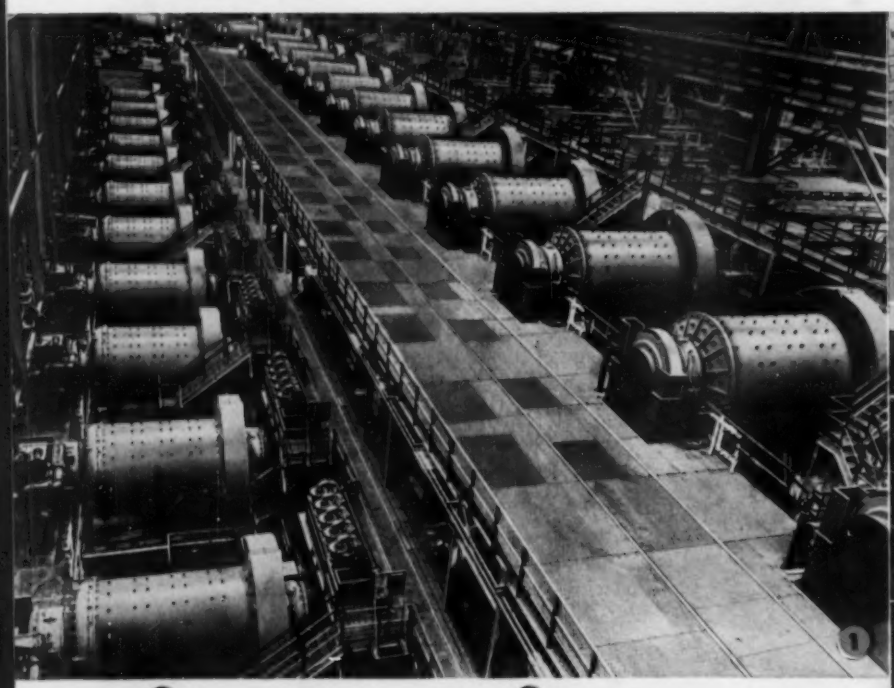
To Increase Production and Lower Operating Costs...Specify NORDBERG MINING MACHINERY

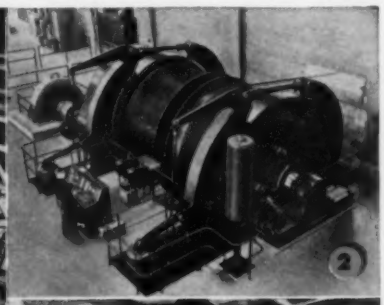
The complete line of heavy-duty Nordberg mining machinery includes Symons® Gyratory Crushers for primary breaking; Symons Cone Crushers for secondary and tertiary crushing; Grinding Mills; Symons Vibrating Grizzlies and Screens; Mine Hoists; and Nordberg Engines for mine and mill power.

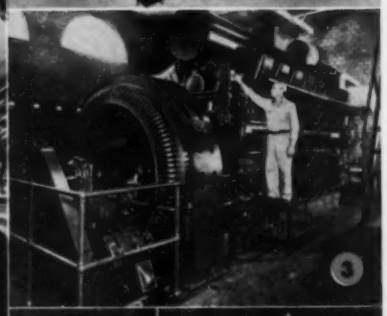
Rugged, heavy duty construction of Nordberg mining machinery assures continuous production at low operating and maintenance costs.

Here is mining machinery that is used by the world's leading producers of ores and industrial minerals.

Write for complete information.







1 GRINDING MILLS . . . Ball, pebble, tube, rod and compartment types for wet or dry, open or closed circuit operation. Sizes to 13' diameter and up to 50' long.

2 NORDBERG ENGINES . . . From small power-units to large stationary plants, for Diesel, Duafuel®, and Spark-Ignition Gas operation, in sizes to over 11,000 horsepower.

3 MINE HOISTS . . . Built in conventional drum types as well as in friction types, for hoisting both ore and men, in a wide range of sizes to meet large coal and metal mining operations.

4 VIBRATING SCREENS and GRIZZLIES . . . In types and sizes to meet practically all requirements from heavy scalping to fine screening applications.

NORDBERG MFG. CO., Milwaukee 1, Wisconsin

NORDBERG

SYMONS . . . a registered Nordberg trademark known throughout the world.

ATLANTA • CLEVELAND • DALLAS • DULUTH • HOUSTON • KANSAS CITY • MINNEAPOLIS • NEW ORLEANS • NEW YORK • ST. LOUIS
SAN FRANCISCO • TAMPA • WASHINGTON • TORONTO • VANCOUVER • JOHANNESBURG • LONDON • MEXICO, D. F.

SYMONS CONE CRUSHERS

Built in 11 different sizes, ranging from 22" to 7' dia., for capacities from 6 to 900 or more tons per hour.

(Illustrated at the right is a typical installation of Symons Cone Crushers and Rod Deck Screens serving a large Taconite Iron Ore producer).

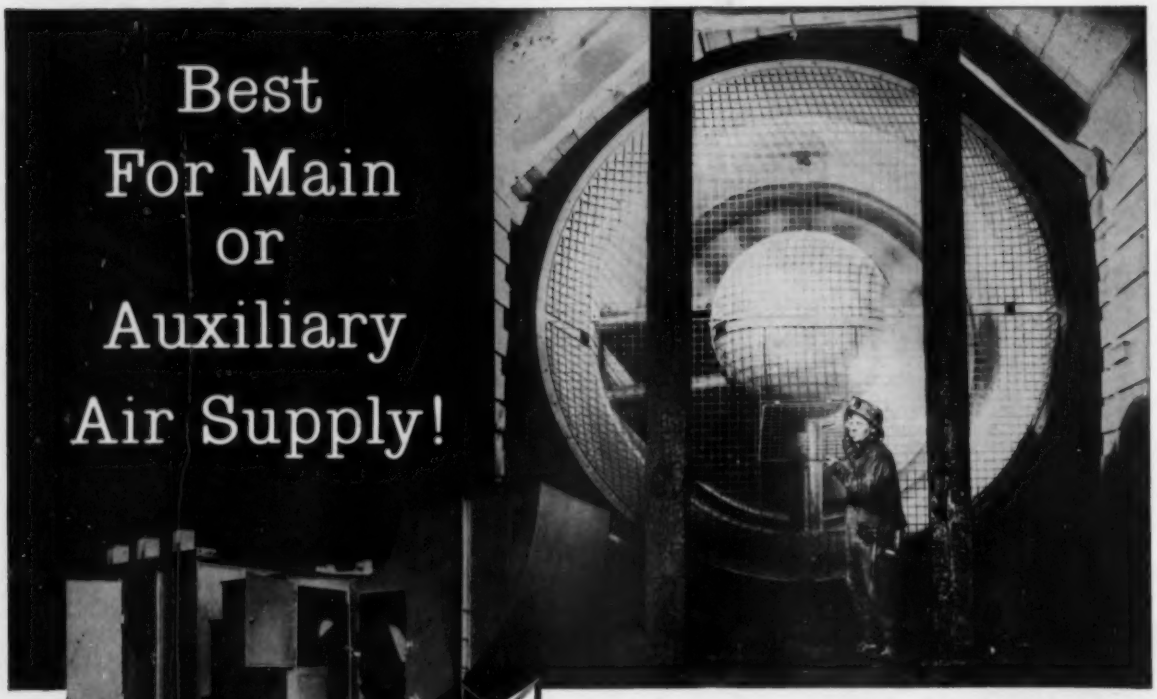
SYMONS GYRATORY CRUSHERS

For heavy-duty primary breaking, available with feed opening sizes of 30", 42", 48", 54", 60" and 72", for capacities to 3,500 and more tons per hour.

©1958, N. M. Co.

M158

Best For Main or Auxiliary Air Supply!



Above: 9′ Joy Axivane Mine Fan teams with an 8′ Joy Fan to provide main ventilation system for Climax Molybdenum Company mine.

Left: 10 H.P. V-belt drive Joy Axivane Fan moves 50,000 feet of air each minute. Ideal for auxiliary or small-mine ventilating duty. Photograph courtesy U.S. Bureau of Mines.

JOY AXIVANE MINE FANS

MAIN AIR SUPPLY Low operating speed, wide operating range, simultaneous . . . and easy . . . blade adjustment, and ready bearing accessibility assure you efficient, dependable ventilation for your mine. The big 9′ Joy Axivane Fan illustrated at top right is in operation at Climax Molybdenum Company's mine in Climax, Colorado. This V-belt driven fan produces air volumes from 81,000 CFM to 770,000 CFM, and above, with pressures up to 15″ w.g. It teams with an 8′ Joy Fan to furnish the main air supply for the Climax mine.

AUXILIARY AIR SUPPLY The 10 H.P. V-belt drive Joy Axivane Fan, illustrated at top left, moves 50,000 feet of air each minute with total pressure of .75 inches. Fitted with reversible motor, this efficient air-moving machine is ready to exhaust stale air or draw in fresh air for the working crews. Remote-controlled adjustable blades allow you precise control of air volume and pressure. It is designed for auxiliary ventilation service in a large mine or for primary ventilation in a small mine.

The vaneaxial design of Joy Mine Fans conforms to the latest formulae of aerodynamics . . . to give you increased efficiency and greater power savings. Joy Axivane Mine Fans are available in sizes up to 12′ in diameter, with air volumes up to 1,120,000 CFM.

AIR MOVING EQUIPMENT FOR ALL INDUSTRY

JOY

Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.

In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario

CL 8867-58

More Work-Ability!

"OUR EIMCO® 635 CONVEYOR LOADER IS THE FINEST PIECE OF EQUIPMENT WE OWN!"

That's the enthusiastic word from T. W. Newell, Vice - President and manager for Shattuck Denn Company. Operating a five foot low-headroom machine at their Bardon Shaft near Moab, Utah, this progressive mining company is presently driving seven headings. Their efficient Eimco 635 Low Headroom Conveyor Loader handles four per shift, loading into shuttle buggies. Complete time cycle of loading each three to four ton buggy is consistently under two minutes and usually closer to 100 seconds; is capable of handling 100 tons per hour.

Frank Garrett is mine superintendent at this operation, which also uses an Eimco Air Tugger Hoist to pull the drill jumbo to one side when it is hoisted out of the shaft and an Eimco 42" Folding Scraper to load their skip pocket.

You'll find that Eimco has the answer to any underground material handling and loading problem. To get the qualified and personal services of an Eimco sales-engineer, just contact the sales office nearest you or The Eimco Corporation, P. O. Box 300, Salt Lake City 10, Utah, U.S.A.

"ADVANCED ENGINEERING AND QUALITY CRAFTSMANSHIP SINCE 1884"

THE EIMCO CORPORATION

EXPORT OFFICE: 51 - 52 SOUTH STREET, NEW YORK, N. Y.
BRANCHES AND DEALERS IN PRINCIPAL CITIES THROUGHOUT THE WORLD

EIMCO B - 428

MINING EQUIPMENT DIVISION
634 SOUTH 4TH WEST
SALT LAKE CITY, UTAH — U.S.A.

JUST PUBLISHED . . .

"ECONOMICS of the MINERAL INDUSTRIES"

- **Foreword by the Honorable Herbert Hoover**
- **Edited by Edward H. Robie, former Secretary of AIME**
- **Text by 36 industrial, legal, and financial experts**

Here is the first book to be released for many years on Mineral Economics. It is the most comprehensive volume ever published on the subject . . . expertly written and edited by top men in the field, as a memorial to Harvey S. Mudd.

For everyone active in any phase of the mineral industries, it will be an invaluable reference source. Young men just starting their careers in geology, mining, metallurgy, or petroleum will find it an ideal means of broadening their knowledge and preparing for added job responsibilities.

Of equal importance, "Economics of the Mineral Industries" will be valuable to experienced engineers and executives to help them keep in touch with the latest in methods and practices. In fact, everyone who has any relation with the mineral industries will find something of direct interest in some of the chapters.

CHAPTER

1. The Significance of the Mineral Industries in the Economy, by Charles White Merrill.
2. Distinctive Features of the Mineral Industries, by Charles H. Behre, Jr.
3. Mineral Titles and Tenure, by Northcutt Ely, assisted by Charles F. Wheatley, Jr.
4. Valuation of Mineral Property, by L. C. Raymond.
5. Cost of Acquiring and Operating Mineral Properties—Part 1. Metal, Nonmetallic, and Coal, by Paul M. Tyler.
   Part 2. Petroleum and Natural Gas, by John R. Crandall, J. W. Glanville, L. Cookenboo, E. D. Pressler, and L. H. Thompson.
6. Part 1. Mine Financing, by William F. Boericke and Carroll C. Bailey.
   Part 2. Bank Loans on Oil and Gas Production, by C. R. Dodson.
7. Part 1. Marketing of Nonferrous Metals and Ores, by S. D. Strauss.
   Part 2. Marketing of Industrial Minerals, by Raymond B. Ladoo.
   Part 3A. Marketing of Iron Ore, by Franklin G. Pardee.
   Part 3B. Marketing of Pig Iron, by George P. Krumlauf.
   Part 4. Marketing of Petroleum and Natural Gas, by Serge B. Jurenev.
   Part 5. Coal Marketing and Trade, by Charles H. Lambur.
8. Dimensions and Changing Patterns of Supply and Demand, by W. C. Schroeder and Richard H. Mote.
9. Part 1. Accounting for the Extractive Industries, by Maurice E. Peloubet.
   Part 2. Special Features of Petroleum Accounting, by Laile H. Thompson.
10. Taxation of Mineral Properties, by Granville S. Borden.
11. Minerals in National and International Affairs, by Elmer W. Pehrson.
12. Government Aid and Regulation, by Evan Just.
13. Conservation and Stabilization, by John Drew Ridge.
14. Labor-Management Relations in the Mineral Industries of North America, by Charles R. Kuzell and W. J. Uren.
15. Industrial Research—Its Aims, Organization, and Facilities, by D. Swan.
16. Gold and Silver—Money and Credit, by Charles White Merrill.
17. Nuclear Energy, by Corbin Allardice and Charles T. Baroch.
18. Minerals in Man's Future, by Zay Jeffries.

The price of "Economics of the Mineral Industries" (770 pages) is $10.00, less a 30% discount to members of AIME. (Extra postage to nonmembers outside of the United States, 50 cents per copy.)

The American Institute of Mining, Metallurgical, and Petroleum Engineers
29 West 39th Street, New York 18, New York

Please send me ..... copy (copies) of "Economics of the Mineral Industries".

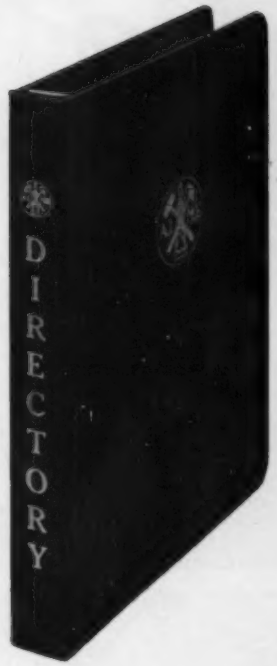
Payment enclosed ..... **Please bill me** ....

Name ..... **AIME Member?** .....

Street .....

City ..... **State** .....

AVAILABLE NOW



This handsome binder for

YOUR AIME DIRECTORY

Holds the Three Sections

We now have this sturdily constructed binder in stock to hold your AIME Directory sections. The Directories of the other two societies are available and the binder is made to hold the three sections in one handy unit.

You will be proud to own and display this book in your home or on your office desk. It's handsomely bound in dark red pebbled Fabrikoid with the AIME seal and "Directory" embossed in gold.

Your copies of the Directories will be preserved during the year—no looking for back copies of the magazine, no dirty, torn, or frayed Directory sections—and the binder will be usable for years to come, holding each year's revised Membership Directories. The three sections will be held neatly, securely, but easily removable.

The binder alone costs only $2.50 and we pay all postage and handling charges. Members may ask to be billed.

The Directory section in which this page appears can be readily removed from the magazine for insertion in the binder—or if you wish, order the complete package for $5.00 which includes the binder and all three Society Directories.

Be sure that you get your AIME Directory Binder from the first shipment, now in stock. Simply fill in the coupon at left, drop it in the mail, and we will see that your binder is sent right out.

AIME Order Department
29 West 39th Street
New York 18, N.Y.

Please send me:

- ☐ AIME Directory Binder Only, $2.50
- ☐ AIME Directory Binder Complete with Three Society Directories, $5.00
- ☐ The Metallurgical Society Directory, $1.00
- ☐ Society of Petroleum Directory, $.100
- ☐ Society of Mining Engineers Directory, $1.00

NAME _____

ADDRESS _____

CITY _____ **ZONE** _____ **STATE** _____

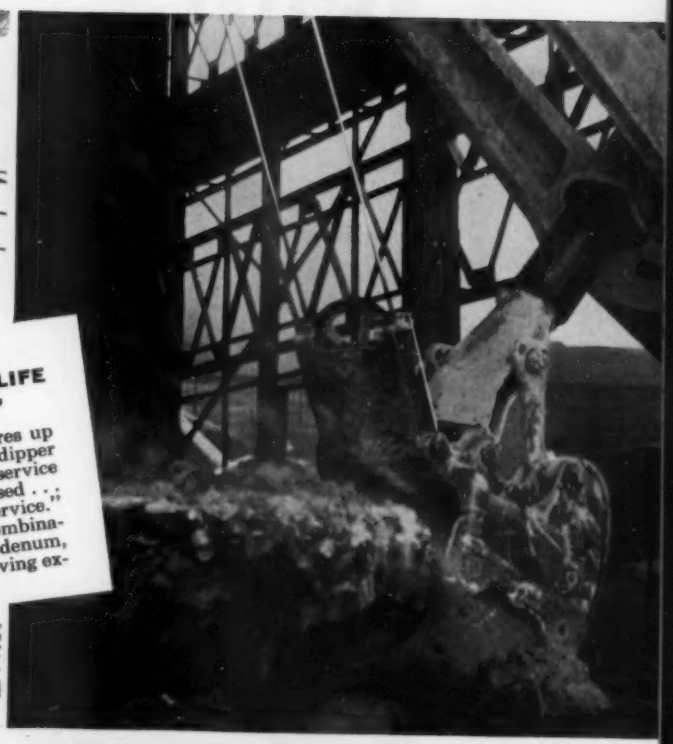
Nonmembers—please enclose remittance with order.

How AMSCO helps you MOVE

User Reports:

"OVER 13 TIMES MORE SERVICE LIFE ...WITH AMSCO 'MML' ALLOY"

"Working in semi-molten slag at temperatures up to 1800°F., an AMSCO 'MML' ALLOY dipper front lasted 528 days. That's 13 times more service life than we got from the type previously used . . .; which gave a maximum of only 40 days' service." AMSCO "MML" ALLOY is a special combination of austenitic manganese steel and molybdenum, specifically developed for applications involving excessive heating as well as severe abrasion.



User Reports:

"AMSCO SIMPLEX TOOTH GIVES 18 WEEKS EXTRA SERVICE"

"We're getting between 15 and 18 weeks extra service by using AMSCO Simplex dipper teeth", reports Mr. Fred Weber, Jr., Vice-President of Vigus Quarries, St. Louis, Missouri. "This gives us almost 4 times the service life we've been getting from standard teeth in our rugged limestone quarrying operation."

Mr. Weber also found that 2-part, reversible Simplex dipper teeth were so much easier and quicker to replace that his shovels were back on the job in no time.

MORE TONS PER DOLLAR

For rugged digging, crushing, pumping, or rebuilding jobs... it pays to ASK for AMSCO!

AMSCO's sole job is to help you fight wear caused by impact and abrasion. AMSCO Manganese Steel—"the toughest steel known"— is today's number one choice for long-lasting dippers, dipper parts, crushers, tractor parts.

AMSCO Alloys, developed to meet unusual wear problems, add extra service life under special and very severe operating conditions.

AMSCO Hardfacing Materials permit economical build-up or repair of worn parts—at a fraction of the cost of new parts. Use this specialized know-how and broad line of "wear-fighting" products to help *your* equipment move more tons per dollar. Ask for AMSCO!

NOW...WELD MANGANESE AS EASILY AS MILD STEEL

"We're getting just the kind of welds and build-up we want with good cost saving to boot," says a user of Nicro•Mang rod. From all over, in a variety of hardfacing applications, reports of success with AMSCO NICRO•MANG are coming in. Users like the stable arc, and wide range of arc length . . . the non-popping, the easy removal of slag . . . and above all the fast build-up. For high strength, superior crack resistance, and easy welding, Nicro•Mang is unbeatable for fabrication and build-up of manganese steel.

"29 YEARS WITH THE SAME 8" AMSCO PUMP"

Haskell Peel, Plant Superintendent at Consolidated Gravel Company, Columbus, Georgia, has shared many experiences with his 8" AMSCO PUMP. One of his favorites is the time that he and his pump almost dried out a lake to recover a sunken dredge. He hooked the 8" AMSCO to more than 1,000 ft. of 10" pipe, and ran it continuously for three days. No wonder the pump is his pet . . . it's been doing the job, pumping 75% sand and 25% gravel, for more than 29 years.

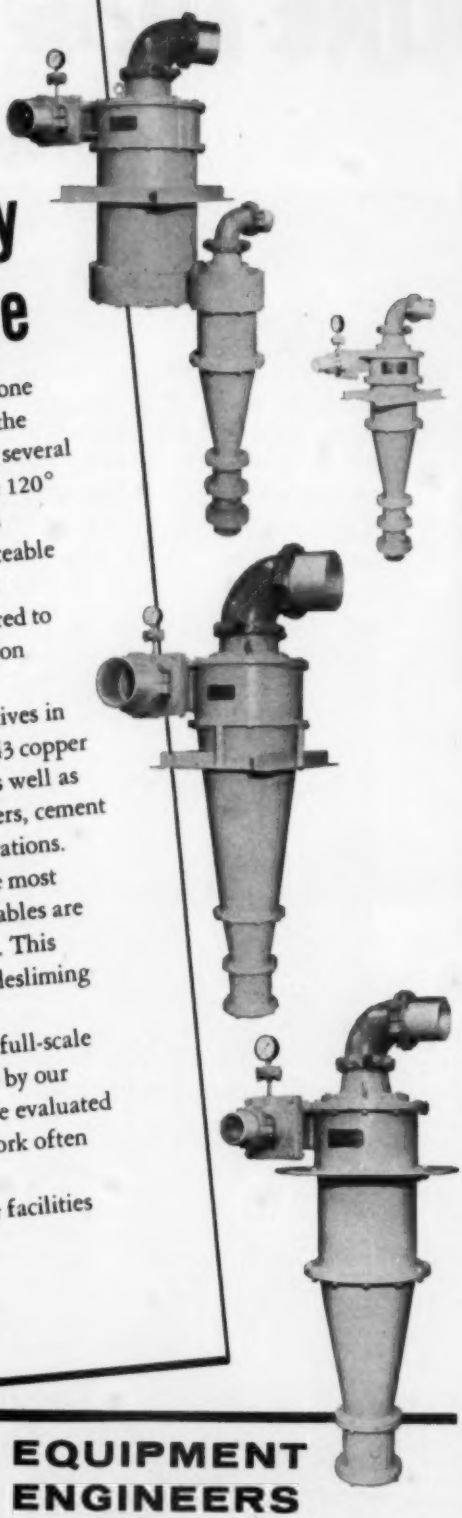
AMERICAN Brake Shoe COMPANY

AMSCO

American Manganese Steel Division • Chicago Heights, Ill.

Other Plants In: Denver • Los Angeles • New Castle, Dela. • Oakland, California • St. Louis
In Canada: Joliette Steel and Manitoba Steel Foundry Divisions
Welding products distributed by Canadian Liquid Air Co., Ltd.

KREBS CYCLONES ...20 models for every classification objective



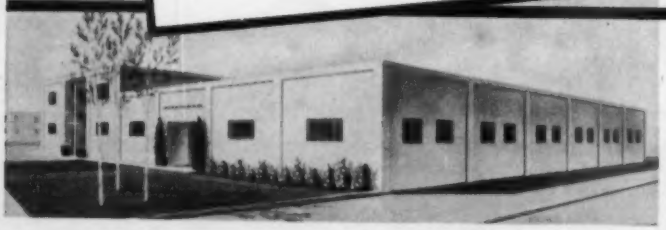
Equipment Engineers Inc. are specialists in cyclone techniques. Ten years of effort concentrated solely on the design and manufacture of cyclones has resulted in several new and vital concepts of dynamic classification. The 120° involuted sweep entry of all Krebs Cyclones increases capacity and performance. The Krebs molded replaceable pure gum rubber liners are still operating as original equipment in 90% of all Krebs Cyclones manufactured to date—hundreds having handled more than a million tons each.

Krebs Cyclones cover a wide range of objectives in extremely diverse fields. There are installations at 43 copper concentrators, 21 iron plants, 22 uranium plants as well as lead-zinc and gold-silver mills, glass sand producers, cement plants, and scores of other industrial mineral operations.

The hydrocyclone, properly designed, is the most potent of all classifiers . . . but only when all variables are correctly correlated to the classification objective. This applies to closed circuit grinding to 20 mesh or desliming to —10 microns.

Our Palo Alto Pilot Plant is equipped for full-scale classifications. Analyses of test results are made by our staff of metallurgical engineers and the data are evaluated on the basis of over-all plant operation. This work often leads to economies and metallurgical gains.

You are invited to avail yourself of these facilities for the study of your classification problems.

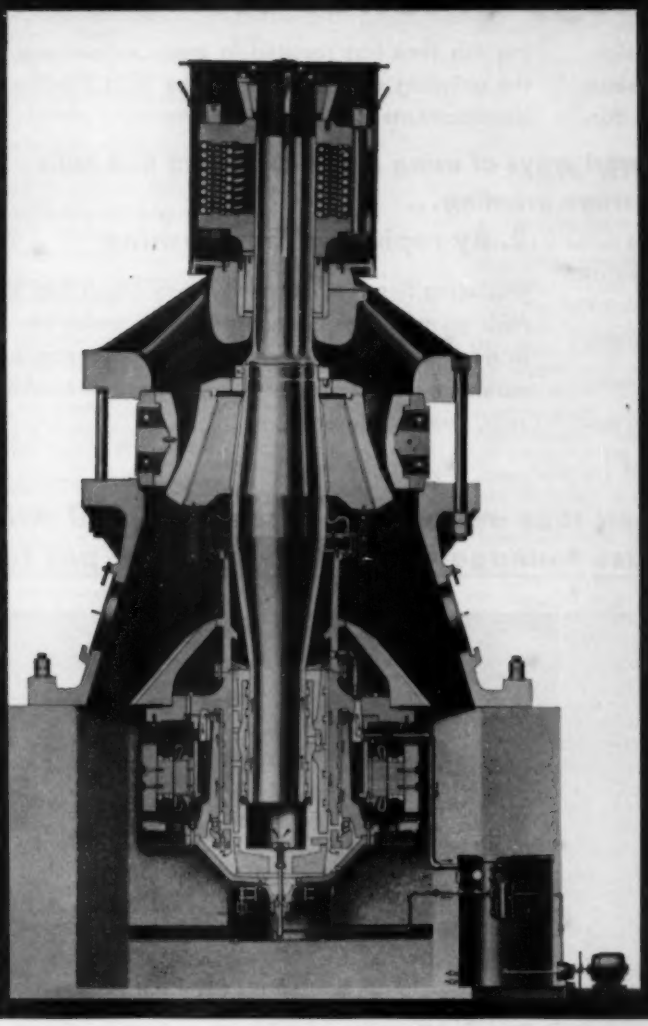


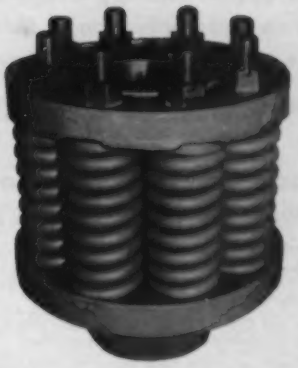
EQUIPMENT ENGINEERS INC.

737 Loma Verde Avenue • Palo Alto California

2-WAY TRAMP IRON PROTECTION

Exclusive with the KENNEDY Gearless Reduction Crusher





Ordinary tramp iron and uncrushable oversize is passed by the quick-acting, positive spring cage, without damage.

The KENNEDY patented built-in drive coupling with its overload device, provides positive protection against breakage from unusually large pieces of tramp iron. Operates only when uncrushable material enters crusher.

Uncrushable material inevitably finds its way into every reduction crusher. Only with the KENNEDY Gearless Reduction Crusher is absolute protection assured—for only KENNEDY provides 2-way protection against costly machine damage.

Write today for your copy of Bulletin No. 58-D describing the many other important features of the KENNEDY *Gearless Reduction Crusher.*

KENNEDY VAN SAUN

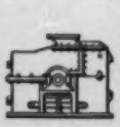
MANUFACTURING & ENGINEERING CORPORATION

405 PARK AVENUE, NEW YORK 22, N.Y. • FACTORY: DANVILLE, PA.

Primary Gyratory

Cuber Senior

Cuber Junior


Hammer Mill

Roll Crusher

Overhead Crusher

Swing Jaw Crusher

HOW MARCY EXPERIENCE

WITH 2-STAGE GRINDING

Increases tonnage at lower cost

Mine and Smelter has specialized in the design, manufacture and application of Marcy Mills since 1915. The extensive research and experience during this time has resulted in many refinements in the grinding process. One of the most significant developments is 2-stage grinding.

Experience has proved two successful ways of using Marcy Open End Rod Mills for 2-stage grinding...

1. By addition of a grinding stage

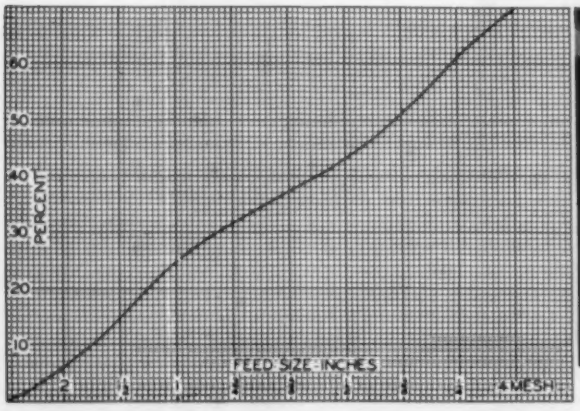
Adding Marcy Open End Rod Mills between existing crushing and grinding circuits...

- Permits larger size crusher discharge, thus greatly increases crushing capacity
- Rod mill can take 1" feed and produce a higher percentage of finished product than crusher
- Rod mill provides finer feed for ball mills, increasing their capacity
- Permits recovery of liberated mineral at coarser size

2. By replacing fine crushing

Replacing fine crushing with Marcy Open End Rod Mills gives all the advantages listed under No. 1, in addition to eliminating the high operating and maintenance costs of complex circuits of crushers, rolls, screens, elevators, etc.

Operating experience has proved that use of Marcy Open End Rod Mills for 2-stage grinding will increase tonnage at lower overall cost per ton



This graph shows increase in mill capacity with decrease in size of feed. For example if a rod mill was used to decrease ball mill feed from 1" to 4 mesh the ball mill capacity would be increased 45%.

This large copper company installed a 9½' x 12' Marcy Open End Rod Mill in parallel with its 2-stage roll-screen circuit. As a result of this test 17 Marcy Rod Mills were installed to replace all roll-screen circuits. Rod Mill feed is 1½" hard ore; grind is to 4% + 10 mesh; tonnage up to 2700 tons per day, each mill. They reduced costs and improved operating conditions.

FOR ACTUAL OPERATING DATA ON 2-STAGE GRINDING WRITE, WIRE OR CALL

Manufacturing Division

MINE AND SMELTER SUPPLY CO.

DENVER 16	NEW YORK 17	SALT LAKE CITY 1	EL PASO
3800 RACE STREET	122 E. 42nd STREET	121 W. 2nd S.	1515 11th AVE.

LICENSED MANUFACTURERS AND SALES AGENTS in Canada, Australia, Sweden, England, South Africa

SALES AGENTS in Peru, Chile, Philippine Islands, Japan, New York City (for Continental Europe) and in principal cities of the U. S.

MINING ENGINEERING STAFF

Editorial Director: Rixford A. Beals

Copy Editor: Margaret E. Sherman

Technical Editor: Henning Nielsen

Production Manager: Marianne Snedeker

Assistant—Departments: Sallyann Burgess

Assistant—Administration: Marilyn McKeegan

Eastern Advertising Manager: Thomas G. Orme, 29 W. 39th St., New York

Mid-Western Advertising Manager: Bob Wilson, Millard Ave., Fox River Grove, Ill.

Southeastern Advertising Representatives: Fred W. Smith & Associates, 1201 Forest View Lane, Vesthaven, Birmingham, Ala.

Western Advertising Representatives: Dillenbeck-Galavan Inc., 266 S. Alexandria Ave., Los Angeles 4, Calif.

SOCIETY OF MINING ENGINEERS OF AIME

President: J. W. Woomer

President-Elect: A. B. Cummins

Past-President: S. D. Michaelson

Regional Vice Presidents: J. D. Forrester, C. E. Lawall, D. W. Scott

Treasurer: R. B. Ladoo

Secretary: John Cameron Fox

Assistant Secretary: Donald R. Tone

Editorial Board: Brower Dellinger (Chairman), N. L. Weiss, Sherwin F. Kelly, R. B. Ladoo, J. C. Fox, R. A. Beals, and member, Advertising Staff.

General Editorial Committee: Brower Dellinger (Chairman), J. W. Chandler, S. E. Erickson, G. L. Judy, Q. D. Singewald, R. A. Beals

Advertising Committee: Sherwin F. Kelly (Chairman), R. A. Beals, H. L. Heller, H. V. Hughes, R. E. Kirk, M. L. McCormack, T. G. Orme, A. E. Seep, H. E. Rowen, W. L. Wearly, S. P. Wimpfen.

Transactions Editorial Committee: N. L. Weiss (Chairman), B. S. Crocker, J. G. Hall, C. T. Holland, D. R. Irving, R. A. Beals

AIME OFFICERS

President: Howard C. Pyle
Past-President: Augustus B. Kinzel
President-Elect: Joseph L. Gillson
Vice Presidents: E. C. Babson, T. C. Frick, W. R. Hibbard, Jr., E. A. Jones, J. C. Kinnear, Jr., R. V. Pierce
Treasurer, Controller: C. R. Dodson
Secretary: E. O. Kirkendall

AIME also publishes: JOURNAL OF METALS (monthly), JOURNAL OF PETROLEUM TECHNOLOGY (monthly), TRANSACTIONS OF THE METALLURGICAL SOCIETY (bimonthly)

MINING engineering **DRIFT**

AVE ATQUE SECTIONEM et MISCELLANUS

• The Uranium Local Section has proved once again the old adage "Build a better mousetrap and the world will beat a path to your door even though you live in the wilderness." In doing so its members have also demonstrated the answer to the question "What does the AIME do for me?"

In words the answer is "Just as much as I do for the AIME." The Uranium Local Section on Jan. 1, 1959, had a total of 56 members by official count—51 of them affiliated with SME, 4 with TMS and 1 with SPE. These members and their wives have just seen six months hard work—and fun—culminate in the 4th Annual Uranium Symposium. That it has been hard work is evidenced by the completeness of the arrangements, the scope and quality of the program, and the smoothness with which everything went off. That it has been fun is proven by the fact that this meeting has become an annual tradition. The Uranium Section's members must enjoy the preparation or they wouldn't come back year after year for more of the same.

There is not enough room here to give the details of the program. It brought together prominent speakers from as far apart as New York and California. They presented papers and took part in discussions before an attentive audience of 600 registrants from every corner of the country. The published notices of the meeting brought inquiries and requests for papers from Austria, France, the Scandinavian and Latin Amercian countries.

Nor is there room to tell about the "Las Vegas Night" entertainment program or the "Party at Steen's." Turn to page 833 for the story and pictures on these and the rewarding field trips.

There is room here to pay tribute to the Uranium Section of Moab, Utah, and to every one of its half-a-hundred members and their wives. They present an outstanding example of AIME in action!—*J. C. Fox.*

WE ALSO SALUTE . . .

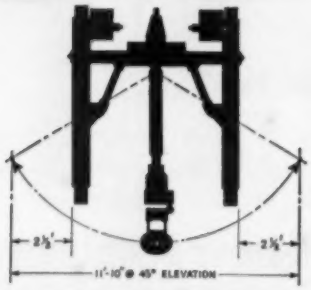
. . . three fellow staff members who have done more than their share in serving the Institute over the years, and who have now retired. Jim Ryan is the most widely known to the membership at large, a result of his hard work at many meetings across the country. Mrs. Gifford was also afforded contact with many individual members through her job in the Secretary's office. But, the champion in years of service, Grace Pugsley, was much better known in other circles than the AIME membership. Her job was to keep company advertising managers and ad agency production people informed, billed, and above all satisfied with their service in the advertising pages of MINING ENGINEERING and *Journal of Metals.* In fact she had been doing this for the last 25 of her 40 years in AIME publications. For the rest of the story see page 823 where we note the official commendations of the AIME Board of Directors.—*R. A Beals*

• New York City is built over a tremendous copper deposit. There are over 300 million lb of copper beneath its pavements.

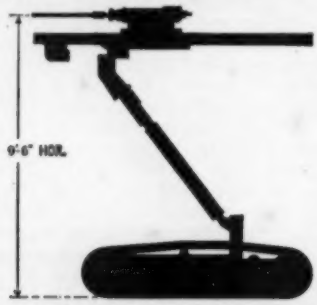
If this were contained in 1 pct ore (instead of in electric wiring) it would be a 150 million-ton orebody.

Mined at the rate of 50,000 tpd, it would take 150 years to mine out the deposit. (Data from the New York Subway System Reader.)

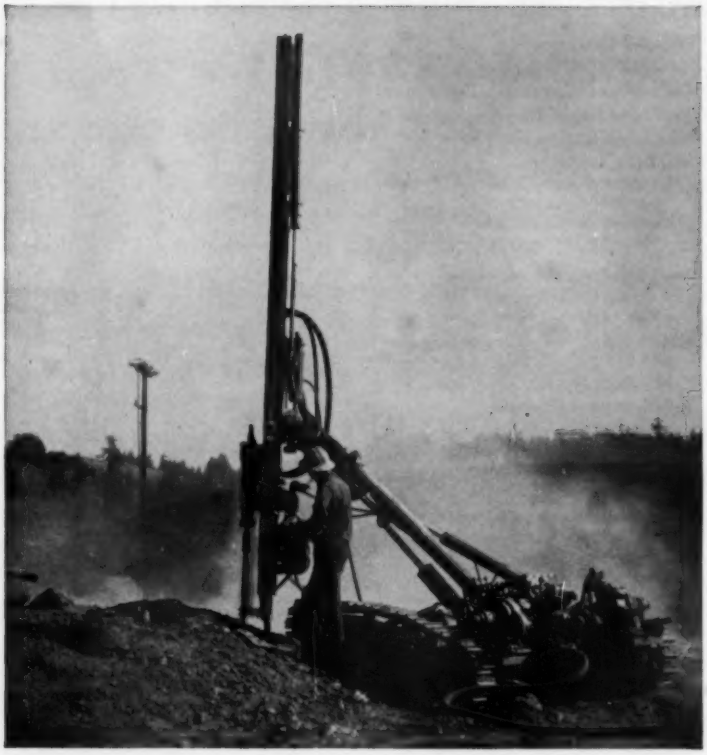
MORE SWING



...MORE REACH



...MORE FOOTAGE



with Gardner-Denver Swing-Boom "Air-Trac"®

TIME TO TALK TIME-SAVING

Gardner-Denver believes there's no substitute for men—it has been our philosophy of growth for 100 years. Your Gardner-Denver construction equipment specialist has helped many uncover ways to speed the pace . . . lower drilling costs. He's a good man to know. Get in touch with him soon.

Swings 11'10" . . . 2½' over both tracks Now drill more hole from one position . . . drill over a ledge from either side. Feed swings 11'10" at 45° elevation . . . moves to 2½' outside of each track with balanced stability.

Reaches to 9'6" height—for horizontal drilling Get better spacing of horizontal holes . . . reach to 9'6" for high breast holes.

Moves quickly . . . safely "Air Trac" is self-equalizing, self-stabilizing, with hydraulic track oscillation. Moves easily, safely over roughest terrain. Designed with an unusually low center of gravity for maximum stability. Long tracks and powerful crawler motors provide plenty of traction. "Air Trac" will pull its own compressor. Tracks available with rubber or steel pads.

Saves time . . . steps All controls conveniently located. Drilling and positioning controls grouped at the front of rig to save steps, setup and drilling time.

Pulls tight steel Powerful Gardner-Denver 5-cylinder radial air motor enables your driller to put the right pressure on the bit in all drilling situations . . . provides necessary pulling power to bring tight steel out of the hole.

Maintains hole alignment Easily handles in-line drilling . . . drilling in fitchery or fractured formations. Creep-free hydraulic boom keeps drill in position . . . track locks keep rig firmly in place in difficult drilling spots.

Drills fast, clean hole Gardner-Denver's line of powerful rock drills is most complete—six hard-hitting models to choose from.

Write for bulletin.

EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

GARDNER - DENVER

Gardner-Denver Company, Quincy, Illinois

Export Division, 233 Broadway, New York 7, New York

In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Ave., Toronto 16, Ontario

IRON & STEEL:

The Paley Report in Retrospect

by JOHN D. SULLIVAN

Agonizing Reappraisal?

At the Annual Meeting in February the Council of Economics presented a session titled "Appraisal of the Paley Report." The session was balanced, and while not exhaustive, the commodities and items included copper, lead, zinc, light metals, industrial minerals, iron and steel, and energy consumption. This paper on the outlook for Iron and Steel is based on one of these presentations and is the first of a short series.

As to the title above, was it agonizing? The answer is mixed. Unfortunately newspaper reports of the session were not as balanced and judicious as were the authors of the papers. One story might indicate that the Report was completely off in its predictions; while another story, might suggest that the report is amazingly accurate. In short, we believe that this series will show that the Paley Report has proven both accurate and inaccurate in its predictions. Just as its recommendations (political and economic) had to be considered very much apart from predictions of consumption trends, so its predictions must neither be accepted as all-good, nor ignored as all-bad. *Editor.*

Resources for Freedom, a report by the President's Materials Policy Commission, commonly termed either the Paley report, after its chairman, or the PMPC report, was issued in June 1952. The data collecting and assembly work for its preparation were done in 1951. The statistical base in most cases was 1950. It reviewed our economy and predicted what it will be in 1975.* The bases for the predictions were given. Consideration was given not only to statistical data and trends but also to technological changes taking place and likely to take place in the ensuing 25 years that will affect our economy. The supply of raw materials was studied and predictions made as to the availability of supply and the sources in 1975. One of the industries covered was iron and steel.

* Or, more broadly, for the decade 1970-1980. Ed.

For the most part the report did not attempt to provide a curve showing annual growth for any industry or commodity. It contrasted 1950 with the probable status in 1975. Interpolation between these dates is difficult and the Commission did not intend that it be used for short interim intervals. It is possible in 1958 to show the actual changes from 1950. The magnitude of the changes illustrates the agreement with some interpolation of the Paley report. Statistical comparisons can be general only because the Commission did not postulate a linear change. A study of the iron and steel industry will show if the general predictions have been realized or if gross errors were made. This paper is concerned with such an analysis. It is concerned with the production and consumption of crude, not fabricated products. It attempts to bring various facets of technical and statistical information on the industry up to date.

JOHN D. SULLIVAN is Technical Director, Battelle Memorial Institute, Columbus, Ohio.

The statistical and technological sections are presented separately, although to a degree they overlap. As presented, a reader may study only one section if he is not interested in the other.

Population: The Paley Commission used population as one of the fundamental facets in predicting materials requirements and consumption. The general prediction of the materials demand by 1975 was based on the estimated size of the total population, the working force, the number of hours worked per week, the accumulation of capital and the rise in productivity per manhour. One of the assumptions was that the population in 1975 will be 193 million with a working force of 82 million. It now appears that this estimate was too conservative. Many economists now estimate that the population will be about 200 million and some predict 220 million in 1975. It was 170 million in 1957.

STATISTICAL

Table I gives information on United States iron and steel production, consumption of materials and capacity in 1950 with estimates from the Paley report for 1957. The writer has interpolated 1957 numbers to the closest 0.5 million tons based on a straight line curve from 1950 to 1957, i.e., assuming that 1957 should be greater than 1950 by 7/25 of the predicted difference between 1950 and 1957 in the Paley report. Other methods of interpolation could be used, but this one will serve to show the general order of accuracy of the predictions.

Table I. Comparisons of Paley Report Predictions and 1957 Data
Millions of Short Tons

	1950	Predicted 1975	Interpolated 1957	Actual 1957
Production				
Crude Products				
Steel mills—ingots and steel for castings	96.8	150	111.5	112.7
Foundries—finished iron castings	15.2	23	17.5	13.5
Consumption				
Pig iron	65	100	75	76.4
Iron ore (assuming 50% recoverable Fe)	119	200	141.5	144.9
Total scrap	68.8	107	79.5	73.5
Capacity (beginning of year)				
Steel ingots	100.0	160	117	133.5
Blast furnaces	71.5	100	79.5	86.6
Byproduct coke ovens	72.5	100	80	73.0

The table also includes the actual data for 1957, taken from conventional sources including *Facts for Industry, Mineral Industry Surveys* and *Annual Statistical Reports of the American Iron and Steel Institute.*

A single year can yield misleading statistical information. For example, production of steel ingots and castings was 112.7 million net tons in 1957, whereas in the preceeding four years it was:

Year	Million Net Tons
1953	111.6
1954	88.3
1955	117.0
1956	115.2

As shown, 1957 production was slightly lower than either 1955 or 1956 but far ahead of 1954 which was lower than 1950. The recent recession had some effect on the production of the fourth quarter of 1957, but on the whole it was a pretty good industrial year.

The pattern of steel production by types of furnace in 1950 and 1957 is shown in Table II. There has not been much change, except for a high percentage drop, although still a rather small tonnage decrease of Bessemer production. The basic open hearth still is the prime producer and since 1950 increased by 1.1 its percentage of the total steel production. The electric furnace also registered a small gain from 6.2 to 7.6 pct of the total production.

As shown in Table III, stainless steel production percentagewise has remained about constant, but in line with the over-all increase in steel production the tonnage increased about 200,000 tons.

Iron Ore: New iron comes from ore in some form. While scrap comprises roughly half of the raw material used in steel making, pig iron must be made from ore to satisfy the growing economy. Detailed consideration is given to iron ore and scrap in this paper.

The Paley report showed 119 million net tons of iron ore consumed in 1950 (page 12, Volume II); however, in compilations and predictions (for example, Table III, page 13, Volume II) 130 million tons was used. Because 119 million agrees with other statistics, it is not clear why 130 million was used. In this paper the assumption is that 119 million is correct.

The analysis of sources of iron was sound but it must be modified on the basis of events since 1952. The Paley report mentioned the coming use of taconites and other formation materials. These are now a reality and in larger amounts at this date than were anticipated in 1952. Part of this can be credited to Minnesota's new tax law applying to taconites. Mention also was made of new foreign sources of ore, particularly from Venezuela and eastern Canada. Current statistics show that these new sources are more important currently than they were predicted to be in 1952. Part of this is due to the technical and economic success of the taconite plants. We can expect more ore from Canada with the completion of the St. Lawrence seaway in 1959.

It has been estimated that operations near the Mt. Wright-Wabush Lake area in eastern Canada eventually may have a capacity of 25 to 40 million tons of concentrates annually. Quebec Cartier Mining Company is reported working on plans towards construction of a concentrator to produce 8 million tons of concentrates per year from about 20 million tons of crude ore.

The Quebec Cobalt & Exploration Ltd., to be operated jointly by Jones & Laughlin and Cleveland-Cliffs will concentrate nonmagnetic ore, coarser than taconites, and containing about 30 pct of Fe. Iron Ore Co. of Canada and Wabush Iron Mines, operated by Pickands-Mather, are making plans to go ahead with another project.

Near Ungava Bay, hundreds of miles farther north, interest continues in projects involving open-pit mining and concentrating. There is study being made to ship concentrates from there to Europe.

Iron Ore Supply: Table I, Chapter 3, Volume IV, Paley Report, gave the following estimates of potential annual supply in the period 1955-65:

Supply of Iron Ore

Source	Million Net Tons: Est. Potential Supply, 1955-65 By Paley Report	Million Net Tons: Actual 1957 U.S. Production Plus Imports
Lake Superior,		
Direct and concentrates	73	86
Taconite Concentrates	17	8
Total	90	94
Southern	11	8
Eastern	11	6
Western	6	11
Labrador-Quebec (Canada)	22	14
Venezuela	28	14
Other South American	6	7
Other Foreign	16	3
Total	190	157

All that can be said is that the right order of magnitude was predicted. Production from domestic western ores in 1957 was higher than the estimated potential tonnage for the period 1955-65. It also appears that taconite and jasper concentrates will be larger by 1965 than predicted.

New Supply Since 1950: In 1957 taconite concentrates from magnetite production in Minnesota was 7.1 million net tons[1] whereas there were no shipments before 1955. In 1956 shipments were 5.4 million net tons.

[1] Iron ore production and consumption in the United States usually are expressed in gross tons. In this paper net tons are used to be consistent with the Paley report and to permit comparisons.

Table II. Production of Steel Ingots and Castings, U. S.

By Type of Furnace	1950: Million Net Tons	1950: % of Total	1957: Million Net Tons	1957: % of Total
Basic open hearth	85.66	88.5	101.03	89.6
Acid open hearth	0.60	0.6	0.63	0.6
Bessemer	4.53	4.7	2.48	2.2
Electric	6.04	6.2	8.58	7.6
Total	96.84	100.0	112.71	100.0

Table III. Production of Stainless Steel as Percentage of Total Steel Production, U. S.

Steel	1950: Net Tons	1950: % of Total	1957: Net Tons	1957: % of Total
Total ingots and castings	96,836,075		112,714,996	
Total stainless, all types	832,309	0.9	1,043,719	0.9

Table IV. Iron Ore in the United States, Domestic Production and Imports Millions of Net Tons

Source	1950	1957
Lake Superior	91	94
Northeast	5	6
South	11	8
West	5	11
Canada	2	14
Chile	3	3
Other sources	4	—
Brazil	—	2
Peru	—	3
Venezuela	—	14
Liberia	—	1
Total foreign	—	38
Average iron content of U.S. ores, per cent	50.38	51.34

Production capacity of Reserve Mining Co. is 8.4 million net tons of pellets per year and that of Erie Mining Co. is 3.9 million or a total of 12.3 million net tons. Reserve is expected to increase capacity to 11 million net tons a year and Erie to about 8 million tons. In addition to the magnetic taconites, flotation plants are treating the hematitic jaspers in Michigan. At the end of 1957 the capacity of two plants was 1 million net tons but plans were underway to increase this to about 2 million. Other companies are expected to produce concentrates either from taconites or jaspers.

The average iron content in 1957 of shipments from Reserve was 63.5 pct dry, 59.9 pct natural. The Aurora plant of Pickands-Mather and Company shipped 63.0 pct dry, 61.8 pct natural. Cliffs pellets from the Marquette range ran 63.6 pct dry and 62.1 pct natural. These contrast with an average 51.34 pct natural for all U.S. ores in 1957. Because of higher Fe content 1 million tons of taconite concentrates is equivalent to approximately 1.25 million tons of the usual 51+ pct ore. In addition, the physical form of pellets make them more easily reduced in the blast furnace. They are reactive and form less slag. The full impact of high-grade concentrates has not been felt. Table V shows the trend to consume less raw materials in making a ton of pig iron, and tacitly shows what may be expected as taconite and similar concentrates are used in higher percentages.

Moa Bay: The Paley report listed the Cuban limonitic laterites as a potential source of iron ore in addition to nickel, cobalt and possibly chromium. It is interesting to note that the plant being constructed by Freeport Sulphur Company to treat Moa Bay ore does not contemplate recovery of the iron oxide. In fact, the residue will be so contaminated with $CaSO_4$ and basic aluminum sulfate that it is doubtful if the iron ever will be reclaimed. Research since 1950 has shown that it is technically feasible to remove nickel, cobalt and chromium to leave a residue sufficiently low in these elements to serve satisfactorily as an iron ore with conventional iron-making processes. The economics of making an iron ore at present prices has not been determined.

Table V. Consumption of Raw Materials Per Net Ton Pig Iron Produced, Net Tons

Year	Iron Ore	Scrap	Mill Cinder, Scale, etc.	Total	Limestone	Coke
1950	1.737	0.056	0.110	1.903	0.429	0.822
1955	1.682	0.049	0.149	1.880	0.387	0.873
1956	1.630	0.045	0.127	1.802	0.362	0.850
1957	1.642	0.040	0.125	1.807	0.350	0.842

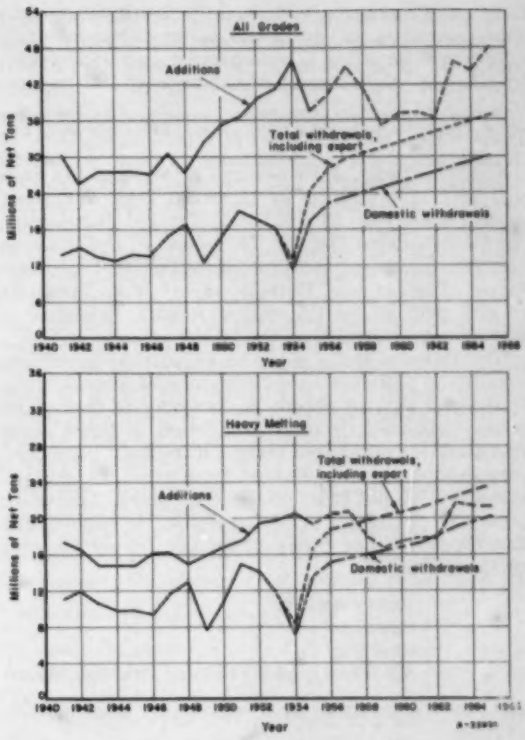


Fig. 1. Estimated additions to and withdrawals from the reservoir of obsolete iron and steel, 1941-1965.

SCRAP

The predictions of the Paley report on the supply of scrap needs special attention. It pointed out that the supply of home and prompt scrap is proportional to the output of ingots and castings and that scrap should be expected to keep in pace with the growth of production. That conclusion is correct. The report concluded that the availability of scrap, therefore, depends on the adequacy of supply of obsolescent scrap. That conclusion, likewise, is correct. The report further postulated that at the probable level of iron and steel output in the 1950's an adequate supply of obsolescent scrap would be difficult to obtain. That prediction needs analysis.

The Paley report concluded that the supply of obsolete scrap, the consumption of which was about 22 million net tons in 1950, would not be much larger in the immediate years ahead. It also concluded that the long-term picture is brighter and that in the 1970's the supply will be greater because of replenishment due to the larger steel production of the 1950's. This conclusion was based on the assumption that the supply of obsolescent scrap in any year will be equivalent to roughly one-third the annual output of finished ferrous products during a period 20 years earlier. On this basis, the report concluded that it is not unreasonable to expect that as much as 32 million tons of obsolescent scrap may be available in 1975.

Good data on obsolescent scrap were lacking when the Paley report was prepared. Since then the U.S.

Dept. of Commerce and Battelle Institute made a comprehensive survey of the national ferrous scrap situation. The study is summarized in a 1957 report by the U.S. Department of Commerce[1] and two reports by Battelle, *A Survey and Analysis of the Supply and Availability of Obsolete Iron and Steel Scrap*, dated Jan. 15, 1957, and *Revised Supplemental Report*, dated Dec. 31, 1957, both to the Business and Defense Services Administration, Dept. of Commerce. The original Battelle report is an appendix to and part of the Commerce Report, hereafter in this paper referred to as the BDSA report.

[1] *Report on Iron and Steel Scrap*, Department of Commerce, House Committee on Banking and Currency, 85th Congress, G.P.O., 1957.

The Battelle study made an exhaustive investigation of the probable availability of obsolescent scrap. It showed that in recent years about 55 pct of all scrap consumed in steel production is home scrap and about 45 purchased scrap. Of the total purchased scrap about 40 pct is derived from prompt industrial scrap and 60 pct from obsolescent scrap. Therefore, about 27 pct of all scrap consumed is obsolescent. The study further broke down the supply of scrap by types into

Heavy melting
Bundles
Cast iron
All other grades (turning, borings, etc.).

The obsolescent scrap reservoir further was classified as that:

1. In dealer's hands
2. Too costly to recover
3. Not being used
4. In secondary use

The period of "secondary use" is defined as "that time the product is held in standby or held for cannibalization".

The report attempted to show how much iron and steel exists within the U.S. economy. Suffice it to say that the cumulative net amount at the end of 1956 was estimated to be 1.5 billion net tons.

A study was made of the average life cycle of iron and steel products for various market classifications. The percentage potentially recoverable and the average life cycle were estimated. These differ from the straight "20-year cycle" of the Paley report. The percentage potentially recoverable (although not necessarily recovered because of economic or other reasons) varied from a low of 13 pct for containers to 100 pct in such classifications as automobiles and marine equipment. The average life cycle varied from a low of 13 years for automobiles to 33 for shipbuilding and marine equipment.

The reservoir as estimated by Battelle and defined as "in secondary use and obsolete iron and steel" is given in Table VI.

One of the most important facets of the Battelle study was the analysis of heavy and light melting scrap. The mill products are changing. Whereas in 1905 approximately 75 pct of all mill products were classified as heavy melting, the percentage dropped to about 55 pct in 1940 and to less than 50 pct in 1955. The automobile, using light sheets, is the principal reason for the shift.

Fig. 1 taken from a supplemental report dated Dec. 31, 1957, from Battelle to BDSA shows the estimated additions to and withdrawals from the reservoir of obsolete iron and steel, 1941 to 1965.

Table VI. Reservoir of Obsolescent Scrap
Millions of Net Tons

	Total	Heavy Melting	Bundles	Cast Iron
Jan. 1, 1956	549	173	144	232
Jan. 1, 1960	583	166	175	241
Jan. 1, 1965	621	154	218	249

Table VII. Estimated Scrap Exports

	Millions of Net Tons
Jan. 1, 1956 to Jan. 1, 1960	25
Jan. 1, 1960 to Jan. 1, 1965	38.8
Jan. 1, 1956 to Jan. 1, 1965	63.8

Estimates are included for all grades and for heavy melting scrap only. Estimated withdrawals of scrap for 1) domestic use only and 2) including exports are given. It is indicated that heavy melting scrap may be in shorter supply during the next few years if exports are unrestricted.

Scrap Consumption, 1957: Total U.S. ferrous scrap consumption in 1957 was 73.5 million net tons, of which 29.9 was heavy melting. The purchased scrap was 33.9 million tons, and assuming that 60 pct was of the obsolescent type, it amounted to 20.3; in 1956, on the same basis, 23.6. These are in fair agreement with the estimates given in the Battelle reports.

The decision on the percentage of scrap to use in open hearth practice is an economic one. With adequate supply of both hot metal and scrap an integrated plant can vary the percentages used depending on the relative price of scrap and the cost of producing pig iron. Scrap prices fluctuate.

Table I shows that in 1957 the consumption of scrap was lower than the value interpolated from the Paley report. Slightly more pig iron was used than was predicted. This is not to be interpreted that there was a shortage of scrap. The contrary was true, and even with exports, supply of scrap exceeded demand in 1957. In this connection it is interesting to note that scrap statistics are given on the gross weight and not the weight of the recoverable iron. The recovery is greater from heavy melting scrap than from Number 2 bundles.

ADDITIVE METALS

The Paley report predicted that the requirements for most alloying metals would expand faster than total steel production. It concluded that the supply of domestic molybdenum and vanadium should be adequate to serve domestic needs until 1975, and that we shall be dependent largely on foreign sources for chromium, nickel, cobalt, tungsten and columbium. The Commission did not worry too much about supply of the foreign materials, save perhaps columbium, except in an emergency when supply might be cut off.

This conclusion has proved to be sound to date. However, because of incentive price purchases, the U.S. developed and stockpiled substantial amounts of tungsten within the United States.

The Paley report estimated the consumption of additive metals in 1975 as shown in Table VIII. It

Table VIII. Additive Metals Requirements

Metal	Unit	Consumption 1950	Est. Required Ment 1975	Interpolated 1957	Actual 1957
Manganese ore	Thousand L.T.	1520	2400	1770	2030
Chrome ore	Thousand L.T.	875	1750	1120	1570(1)
Nickel	Thousand N.T.	100	200	130	120
Molybdenum	Million pounds	26	70	38	30
Cobalt	Million pounds	9	40	18	9(2)
Tungsten	Million pounds	6	15	9	8

(1) Metallurgical, refractory and chemical = 67, 25 and 8 per cent, respectively.
(2) Total for metallic purposes 7.3 million pounds.

should be stressed that all of these additives have use other than in iron and steel production. However, the report was interested in supply *per se*. Table VIII shows the consumption in 1950, that predicted in 1975, and by straight line interpolation (7/25) the 1957 estimated consumption. The actual 1957 consumption is given in the last column. A few comments are made in the paragraphs following on individual additives.

Manganese ore consumption is higher than predicted but part of this is explained by the fact that the ore is lower in grade. Consumption of cobalt was lower presumably because its use in high-temperature alloys did not grow as expected. This also may explain in part the lower consumption of molybdenum.

Manganese: The Paley report considered the world's supply situation and U.S. demands. It also discussed in some detail proposed processes for securing manganese from low-grade domestic sources. It concluded that the supply of high-grade ores available to the United States to 1975 and beyond will be adequate to meet the growing demand. Resources are abundant and obstacles to expanding production can be overcome as demand increases. This conclusion is borne out to date.

The report further recommended that as an insurance against disruption of supply by war, research should be continued to develop processes to utilize low-grade domestic ores and to reduce the requirements of manganese in steel production. Stockpiling of foreign ores also was recommended.

Table IX shows the source of manganese ore used in the United States in 1950 and 1957. Africa already was an important supplier in 1950, and imports have grown. In 1957 it continued as our number one source of supply. India, still in the number two position, increased shipments. Major increases have come from the Western Hemisphere, particularly from Brazil and Mexico. Cuba also is an important supplier.

Nickel: Nickel production has expanded in North America, particularly in Canada. Both International Nickel Co. and Falconbridge have increased production capacity. The Moak Lake deposits in Manitoba will add greatly to Canadian production. Sherritt Gordon, a newcomer in Canada, produced 20,670,000 lb of nickel in 1957. The ammonium carbonate leaching plant at Nicaro, Cuba, expanded 70 pct to increase production capacity from 30 million to 50 million lb as oxide per year. Freeport Sulphur Co. is completely a chemical plant to treat iron laterites from Moa Bay, Cuba, to produce 50 million lb per year of nickel and about 4 million lb per year of cobalt. The plant is nearing completion and production of both nickel and cobalt should start by the middle of 1959.

Cobalt: Howe Sound produced approximately 2.5 million lb of cobalt per year in 1956 and 1957 from mining operations in Idaho and chemical processing in Utah. Recent news reports rumor that these operations will close.* New coming production by Freeport Sulphur Co. was mentioned under nickel. Ample supplies of cobalt are available both from Canada and Belgian Congo.

* The plant now is closed (7-24-59).

Columbium: The Paley report had more concern about the supply of columbium than other additive metals. This picture has changed because of the incentive purchase plan of the U. S. Government which opened many columbite deposits, particularly in Africa. In addition, discoveries have been made of vast pyrochlore deposits in different parts of the world, for example in Canada, Scandinavia and Africa. Much research remains to be done to make recovery of columbium from them as cheap as from columbite ores. However, columbium is available from them at a cost, if and when the demand requires that this source of supply be used.

The Paley report did not foresee shortages of limestone, refractories, or fluxes before 1975. This prediction is sound.

Comparison of Predictions, Paley and BDSA Reports: The BDSA report gave statistics for 1955 and estimates for 1960 for iron and steel production and for consumption of ferrous metallics. It is interesting to contrast the BDSA figures with the linear interpolated values based on Table III, Vol-

Table IX. Manganese Ore Used in the Production of Ferro-Manganese in the U. S., by Source of Ore

Source	Thousand, net tons 1950	1957
Domestic	105	364
Africa	606	743
Brazil	129	600
Chile	7	28
Cuba	43	159
India	448	678
Mexico	26	218
Philippines	5	8
Turkey	3	13
USSR	44	0
Peru		15
Venezuela		4

Table X. Comparison of Some Predictions in the Paley and BDSA Reports

	BDSA Millions of Net Tons		1960 Linear Interpolated from Paley Report
	1955	1960	
Total production	134	169	—
Steel ingots	117	148	118
Iron and steel castings	17	21	—
Total ferrous metal consumption	150	199	163
Pig iron	77	97	79
Scrap	81	102	84
Home	45	57	45.5
Purchased	36	45	38.5
Obsolete	21.5(1)	27(1)	26

(1) Assuming 60 pct of purchased scrap to be obsolete (BDSA).

ume II, Paley report. This is shown in Table X. The BDSA report predicted a higher output of steel ingots in 1960 than the Paley report. It also predicted a higher total ferrous metal consumption with more scrap and pig iron consumed. The BDSA report predicted only a slightly higher consumption of obsolescent scrap than Paley.

Table I shows that for 1957 the actual production of steel ingots and the consumption of both pig iron and iron ore was close to those predicted for that year on a linear interpolation of the Paley report. It also showed that less total scrap was consumed than would have been predicted by the interpolation used.

TECHNOLOGY

Volume IV of the Paley report postulated changes that might be expected to take place in iron and steel making between 1950 and 1975. Some of the facets are discussed in other sections of this paper. A few are commented on in the paragraphs following.

Pig Iron: A basic premise was made that 98 pct of the iron in iron ore is recovered as pig iron. This recovery still can be accepted.

The use of high top pressure, say 10 to 12 psi, was discussed as a means of increasing furnace output and decreasing coke consumption. Although the first high-top-pressure furnace was installed during World War II, the change has been slow and gradual. Better preparation of blast-furnace feed leads to lower dust losses and permits higher blowing rates; so the rate of shift to high top pressures has not accelerated as fast as predicted.

Enriched oxygen in blast furnaces was mentioned as a technical development that could be expected to grow. Many existing blast furnaces, because of design, cannot take advantage of enriched oxygen, but as new furnaces are built more oxygen probably will be used. In some plants water vapor is introduced with the air. Some operators use it to get smoother furnace operation; others to take advantage of the fact that water contains 89 pct O and is an oxidizing agent.

Improvements in Blast Furnace Feed: Under iron ore the effect of higher grade ores was mentioned. Considerable attention also is being given to improving the quality of the blast-furnace burden as was predicted in the Paley report. The average ore is finer than it was a few years ago, and sintering or otherwise agglomerating the charge is practiced more widely. Some plants are adding limestone to the sinter charge to produce substantially a self-fluxing sinter. Output of furnaces has increased. It is understood that much progress has been made in Russia on the use of a high percentage of sintered material in the blast furnace charge, and that semi-self-fluxing sinter is being used in at least one large plant.

Coke: Much attention has been given since 1952 to the mechanical properties of blast-furnace coke. Studies have shown that the mechanical properties must be evaluated at operating temperatures because room temperature testing often gives misleading results. The Paley report had a somewhat too pessimistic view on coke, particularly on the continued supply of high-quality material, although a continued supply of low-sulfur coke remains a problem.

Low-Shaft Blast Furnace: The low-shaft furnace was mentioned as a possible substitute for the standard blast furnace, particularly if weaker coke had to be used. There appears to be little if any interest in the low-shaft furnace in the United States at the present time.

Direct Reduction: The Paley report (page 35, Volume IV) predicted that direct-reduction processes will not compete with the blast furnace as a major producer of primary iron. It predicted their use will be where coke is not available and in small-scale operations in remote places and with small ore bodies. Mention also was made of direct-reduction processes as a source of synthetic scrap. Perhaps more research has gone into these processes since 1952 than was anticipated by the Paley report. Although most steel producers discount the immediate commercial feasibility of direct-reduction processes, except in special situations, it is significant that most major U. S. steel companies are working in the field. The high capital investment of blast furnace and coke ovens has been an incentive in this direction. Another incentive is that much of the iron ore of today is finer than that of a few years ago, and some ores have a tendency to disintegrate in the blast furnace. Today, we hear of the R-N, the H-iron and other direct-reduction processes that have gone through the pilot-plant stage. To date there are no commercial installations in the U. S. and it is unlikely that any significant tonnage of ore will be so treated before 1965.

Blast Furnace Improvements: The proponents of direct-reduction processes too frequently base their arguments on the premise that there will be no improvement in the blast furnace. This is a false assumption. Better preparation of the feed, including sintering (even self-fluxing); a better understanding of coke requirements; use of oxygen in some form, either enriched air or introduction of H_2O in the blast; high top pressures; improved mechanical handling; and larger furnaces have lowered the effective capital investment because of greater furnace output. Labor costs are relatively cheap in a blast-furnace operation; so operators are not going to abandon the classical blast furnace. In addition, the capital has been spent for those plants now in existence. They will not be abandoned.

Bessemerizing: The Paley report discussed "Bessemerizing" processes which utilize a higher percentage of hot metal than the open hearth. The Turbo-Hearth was mentioned and it was tacitly implied that it would find major use in the steel industry. This prediction has not materialized. For the time being, at least, that process is on the shelf.

The report did not stress the future possibility of Linz (LD) and other oxygen-blown basic converters. In the last five years four steel companies in the United States have installed a total of 12 converters with an annual tonnage capacity of 4 million tons. While the capital investment for steel making *per se* is lower than in the basic open hearth, the process requires more hot metal which in turn requires high-capital blast furnace and coke-making facilities. The oxygen converter processes will continue to grow.

The use of converters is tied up with the supply and price of scrap. As shown elsewhere in this paper the Paley report was too conservative in its estimates of the potential availability of obsolescent iron and steel scrap. Within the next decade the lack of a sufficient supply of scrap will not drive steel manufacturers to bessemerizing processes. However, unless there are less frequent violent

fluctuations in scrap prices—$32 to $62 in a single year—they may use more hot metal.

The world's international steelmaking congress opened in Belgium on June 23, 1958. (See *Journal of Metals*, October, 1958.) Many items of interest to U. S. steel men were discussed, particularly those relating to new production techniques. Attention is directed to the fact that European steelmaking, with high-phosphorus ores, makes major use of the Thomas basic converting process. New techniques include oxygen-steam and oxygen-carbon dioxide bottom blowing. A new plant at La Sambre in Belgium is the first commercial installation for bottom blowing with powdered CaO in conjunction with oxygen-steam. The process is based on the finding that simultaneous blowing of oxygen and lime powder makes it possible to eliminate the phosphorus during the decarburizing process.

It is asserted in Belgium that by using an oxygen content of 28 to 34 per cent in the blast of a conventional bottom-blown converter, steel quality has been improved and capacity increased 15 pct. ARBED in Luxembourg using enriched oxygen in bottom-blown converters has experienced lower nitrogen in the steel.

The use of oxygen-steam or oxygen-CO_2 in about equal quantities has had as a prime objective the attainment of low-nitrogen steel. The LD, top-blowing process, likewise, achieves low nitrogen.

The progress of all of the processes should be followed with interest in the United States. Because most of our ores are low in phosphorus, the oxygen-lime blowing process is not of so much interest as those processes aimed primarily at low nitrogen in the steel. As previously stated, any increase in steel production depending on hot metal requires additional blast furnaces and coke ovens.

Basic Open Hearth: Most steel companies are using oxygen in the basic open hearth furnaces to a greater extent than was implied by the Paley report. Many companies use oxygen in melting down scrap. This is true particularly in newer furnaces which have large enough charging doors and adequate charging equipment to get the scrap in fast enough to take advantage of the more rapid melting rates possible when using enriched oxygen in combustion.

It now is standard practice to use oxygen in making low-carbon steels, particularly to lower the carbon from 0.25 pct to the desired level. More steelmaking operations will use oxygen at higher carbon levels with the oxygen introduced through the roof using specially designed tubes or nozzles. Basic roofs will increase the practice. As a result, we can expect competition between oxygen in basic converters and in the basic open hearth employing higher than common percentages of hot metal in the charge. Because of its greater flexibility, including the possibility of using higher scrap percentages, much of the pneumatic processing will be done in the open hearth.

The Paley report (page 35, Volume IV) stated:

> "The sulfur problem and some other factors are militating against the basic open hearth, and in spite of its fine past record and its present paramount position, there is reason to believe that it may be approaching obsolescence. This does not imply any sudden abandonment, because open-hearth furnaces are still being built, but the prospect is that they will lose their dominant position in the Nation's steel industry during the next quarter century and be replaced by other types of furnaces."

The writer believes that this statement about the future of the open hearth is too pessimistic. The flexibility of the open hearth process mitigates against its obsolescence. As shown in Table II the percentage of total steel produced in the open hearth increased from 88.5 pct in 1950 to 89.6 in 1957. The electric furnace in 1957 produced only 7.6 pct of the total. The use of oxygen in the open hearth has grown faster than the Paley report anticipated. The all-basic furnace will increase this even more.

Electric Furnace: The electric furnace will continue to grow in importance. Its use has been limited to virtually a complete scrap charge. There is not enough scrap available to expand electric furnace production indefinitely. The source of new iron is iron ore. It may be expected, however, that oxygen will be used in electric furnaces, as in basic open hearths, to permit the use of charges higher in hot metal. It must be pointed out, however, that the apparent advantage of lower capital cost of the electric furnace begins to fade when more hot metal is used in it, because to get hot metal also requires high-capital-cost blast furnaces and coke ovens.

The report (page 36, Volume IV) suggested that the electric furnace and the basic surface-blown converter would make a complementary team, the former using the scrap and making all the high-carbon and alloy steels with the latter using pig iron to produce low-carbon steels or to furnish hot-blown metal to the electric furnace when scrap is in short supply. To date this has been achieved only to a minor extent, but the trend will continue upward.

The prediction (page 40, Volume IV) that eventually the electric furnace probably will replace the open hearth as the chief producer of steel is still far in the future.

Acid Open Hearth: The Paley report also predicted the ultimate disappearance of the acid open hearth furnace. It requires a scrap charge. As shown in Table II less than 1 pct of the total steel is made in acid operations. The electric furnace can be expected gradually to replace the acid open hearth, but there still will be some of the latter even in 1975.

Continuous Casting and Hot Extrusion: The Paley report predicted that the home scrap per ton of steel produced will be reduced appreciably by processes such as continuous casting and hot extrusion. While research continues, to date these processes are unimportant and have no affect on scrap supply. The BDSA report virtually ignored decreases by 1965 in the supply of home scrap because of such processes.

The international steelmaking congress in 1958 demonstrated the interest in Europe and Russia on continuous casting. The delegates inspected two experimental continuous-casting plants.

Vacuum Casting: Much attention is being given both in the U.S. and Europe to the use of vacuum in ingot casting. This is primarily for steel quality, particularly the removal of hydrogen, and will have but minor effect on plant capacity or raw materials usage.

Corrosion: The Paley report discussed corrosion and pointed out means such as coatings and galvanic protection to lower losses. The trend continues. The actual loss of steel by corrosion is not great because most of the product returns as scrap. The dollar losses are more significant. Pinhole corrosion can

cause loss of a piece of equipment even though the actual loss in the corrosion may be one per cent or less. In the BDSA report referred to in the section of this paper on scrap, the weight loss was assumed to be one per cent.

The Paley report also said that increasing freight rates, successful development of continuous casting processes and the trend to electric furnaces are factors tending to decentralize the steel industry. Despite the building of new capacity in the west and southwest, the steel industry still remains centralized percentagewise in a few areas in the middle west and east.

The shell molding process in foundries mentioned in the Paley report as one contributing less scrap continues to grow but to date has had no significant effect on the tonnage of scrap from castings.

SCHUMAN PLAN COUNTRIES

No analysis of the U.S. iron and steel industry can ignore the Schuman Plan or more properly termed the European Coal and Steel Community, which was in the formation stage but not a reality when the Paley report was prepared. It now is in operation and most of the final provisions have been effected or are near completion. In effect, the six countries, Belgium, France, Germany, Italy, Luxembourg and the Netherlands have formed a common market for iron ore, pig iron and steel products. Tariff barriers are removed, prices are stabilized and shipments of raw materials, such as iron ore and coal, are intended to eliminate gross inequalities in production costs. After a slow start that required adjustment of basing points, quotas, etc., the plan now appears to be operating smoothly. Its success has been so great that the same countries have formed a European Common Market for virtually all manufactures. Even labor will be able to migrate from one country to another without border restrictions once the common market plan is in full effect. The importance of the Schuman Plan countries on iron and steel is shown in Table XI. With tariff and other barriers removed, there is bound to be some effect on United States exports to these countries. The plan has been in operation too short a time to evaluate quantitatively its full effect on our industry.

Russia already is an important factor in the world's iron and steel. The estimated production in 1950 and reported actual figures for 1957 are given in the tabulation following.

USSR

Regardless of trade between the U.S. and Russia, the latter is exporting and likely will continue to export in increasing amounts to Western nations. This should relieve the raw materials supply situation of some steelmaking commodities. Russia in 1956 was the world's largest exporter of manganese ore, and any exports from Russia to countries now depending on India, Africa and elsewhere for their supply will allow larger imports from those exporting countries into the United States. While we do not have a tight manganese ore supply situation, we probably can be more selective and get higher grade ores.

Mention previously was made of advances by the Russians in the preparation of blast furnace feed and in continuous casting of steel. They are reported to be using higher top pressures in blast furnaces than is common in United States practice; also that they have made progress with an all-basic open hearth.

Table XI. Production of Pig Iron, and Steel Ingots and Castings, E.S.I.C., Thousands of Net Tons
USSR

	Pig Iron		Steel	
	1950	1957	1950	1957
Belgium	4,070	6,158	4,180	6,917
France	8,650	13,314	9,550	15,540
West Germany	10,450	20,236	13,350	27,014
Italy	630	2,431	2,610	7,481
Luxembourg	2,760	3,713	2,700	3,850
Netherlands	500	773	540	1,306
Total of 6 countries	27,060	46,625	32,930	62,108

Table XII. Production of Pig Iron and Steel Ingots and Castings, U.S.S.R.

Thousands of Net Tons

Pig Iron		Steel	
1950	1957	1950	1957
21,500	40,800	29,800	56,218

Exports and Imports, U.S.S.R.; Various Iron and Steel Products

Thousands of Metric Tons, 1956

	Exports	Imports
Pig iron	1,359	498
Rolled iron and steel	1,830	597
Iron and steel tubes	205	145
Iron ore	9,124	—
Manganese ore	918	—
Chrome ore	218	—

CANADA

Canada is becoming important not only as a producer of iron ore, as was discussed in sections of this paper, but also of pig iron and steel. The annual production capacity of blast furnaces increased from 2.6 million net tons in 1951 to 4.2 million in 1957. Production of pig iron was 2.5 and 3.7 million net tons in 1951 and 1957 respectively.

Annual production of ingots and steel for castings increased from 3.5 million net tons in 1951 to 5.0 in 1957. Scrap consumption was 2.7 million net tons in 1957. This contrasted to 2.9 million net tons of pig iron consumed. Canada has become a major producer of iron ore. Total production increased from 3.6 million net tons in 1950 to 22.4 in 1957. The largest increases came in 1955 when production increased nearly 9 million tons from 7.4 million tons in 1954 to 16.3 in 1955. It increased another 6 million tons in 1956 to 22.3.

As was mentioned in the section on iron ore, there is much current activity in the Province of Quebec. The St. Lawrence seaway will be a boon to further ore production in eastern Canada, particularly for the U.S. market.

It will be interesting to re-examine the Paley report as it relates to iron and steel, say about 1965.

BLASTHOLE MINING AT GECO

Through careful planning the Geco mine has developed from a prospect in virgin country to one of Canada's larger base metal mines in less than four years. High efficiencies have resulted from good fragmentation and use of gravity movement of ore to crusher by the transfer raise system, followed by conveyor movement of ore to the shaft loading pocket.

by G. M. T. MARSHALL

Plans to bring the Geco Mines property in Manitouwadge, Ont., into production began in 1954. At that time over 12 million tons of copper-zinc ore were indicated in a zone 2700 ft long. A concentrating plant was built to handle 3300 tpd of ore and a production shaft was sunk about 1500 ft.

MINE LAYOUT

Vertical attitude, width, rake, and competent country rock of a 4-million ton orebody west of the main diabase dike suggested a system of blasthole stopes, undercut with scram drifts connected by a transfer raise system to a crusher on the 1250-ft level and this system was employed. A 42-in. conveyor on this level transfers the ore about 1200 ft to a loading pocket at the No. 1 shaft. The system has a number of advantages: 1) Cost of tramming is eliminated. 2) Rate of extraction from any stope is controlled only by the scraping capacity of the scram. 3) Rate of extraction from the stoping area can be very rapid. Fast extraction makes it possible to cut mining costs for the following reasons: The number of stopes actively producing is kept to an economical minimum; the operating area is concentrated—manpower can be used more effectively; and active life of the stoping block is short, making ground support problems simpler and less costly.

Before completion of underground work, it was hoped that ore transfer raises could be maintained through the fault zone and the main diabase dikes. The fault zone is a series of parallel movements with the ground very schistose and broken up, requiring continuous support. The diabase dikes are weak and blocky and also must have support. This has made it necessary to plan to leave a narrow block of ore adjacent to the diabase, and also a block of ore in the fault zone, to be recovered later by supported mining methods.

The second block of blasthole stopes to be mined has been laid out from the 1050 to the 450-ft level.

The decision to install a second crusher and to use cross-scraping for this second stoping block was made only after exhaustive studies of means of transporting this ore to the first crusher. An interesting result of this study was the finding that if at least 500,000 tons could be dropped by gravity to a crusher, it would be more economical to install a crusher and conveyor than to tram.

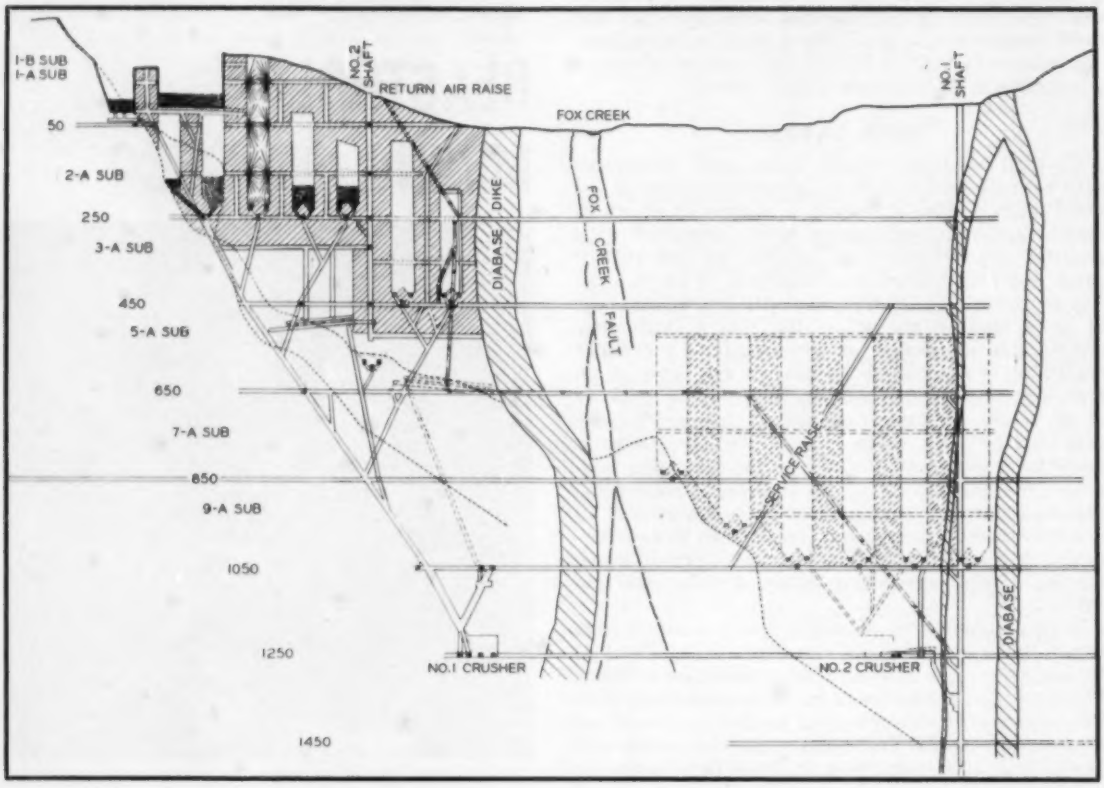
Geology: Favorable host rock for the copper-zinc deposition appears to have been a sericite schist zone generally separating the grey gneisses to the south from the granites to the north. The ore minerals—chalcopyrite and sphalerite—which are associated with pyrite and pyrrhotite and minor amounts of other sulfides are disseminated throughout the sericite schist, and are also in a massive sulfide zone in the center of the sericite schist. Cutting the ore on a north-south strike and dipping from 75° to vertical, are several diabase dikes varying in widths from 100 ft down to less than 1 ft. Along Fox Creek (see section), striking north-south and dipping very steeply, is a major fault zone, with a total horizontal displacement of 150 to 300 ft. The vertical displacement has not been determined but is believed to be relatively small. The ore zone plunges at approximately 40° from the west and appears to be controlled by the bottom of a folded structure in the sericite schist. Along the bottom of this structure the ore will frequently split into two or more fingers that have vertical extensions of up to 100 ft in places. The top of the ore plunges below the surface of No. 1 shaft, but the exact plunge of the eastern extension has not been determined to date. The dip is almost vertical with the contact walls parallel to the strike of the formations.

G. M. T. MARSHALL is Chief Engineer of Geco Mines Ltd., Manitouwadge, Ont.

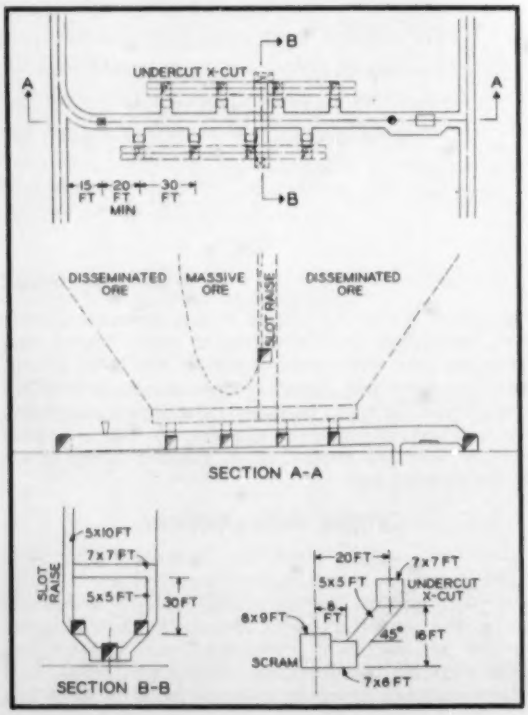
STOPE PREPARATION

The first mining block was laid out with 50-ft wide transverse stopes separated by pillars of 50, 60 and 70-ft widths. The relatively narrow stopes allowed the initial block of ore to be divided sufficiently to maintain anticipated production. The second mining block will de divided into stopes and pillars varying in width from 60 to 70 ft. It is felt

Geco Mines Ltd., Longitudinal Section



Stope Development



that about 70 ft is the most efficient width for blasthole stopes.

Contemporary practice and the need to meet a production deadline suggested an initial stope height of some 300 ft. But because the walls stood up remarkably well in the first stoping block, and since the physical nature of the second block of ore suited a higher stope, it was decided to mine the stopes with 500-ft walls.

Development of the initial block of stopes was from two adits and from the No. 2 shaft which was developed to meet the scheduled production date. This centrally-located shaft has been very useful for developing and servicing the sublevels. For the second block of stopes a service raise was located almost 100 ft north of the ore. This was to be used as an escape raise above the 1050-ft level, a fresh-air way, and to carry future sand lines for backfilling, as well as for servicing the sublevels. It will be equipped with a conveyance for moving locomotives and mechanical loaders.

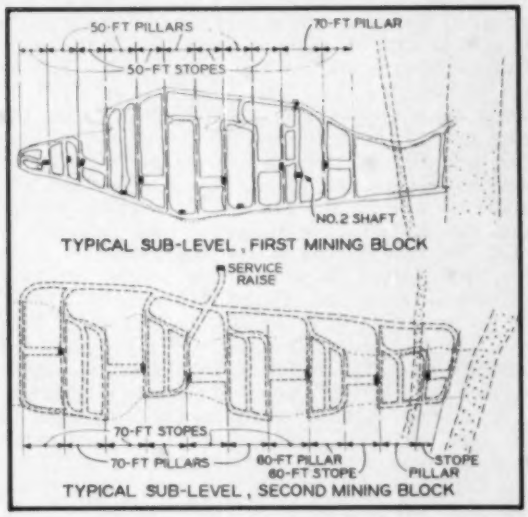
In certain instances when ore contacts are gradational, cut-off grades can vary considerably over the life of a stope due to changing metal prices, and this was considered in the layout. The first block of stopes is primarily a fringe drift layout. In the second block of stopes the initial fringe drives are on the south side of the ore because this contact is fairly well-defined. Since the north contact is a varying grade cut-off, the north fringe drives will be made only after sampling by relatively short diamond drillholes.

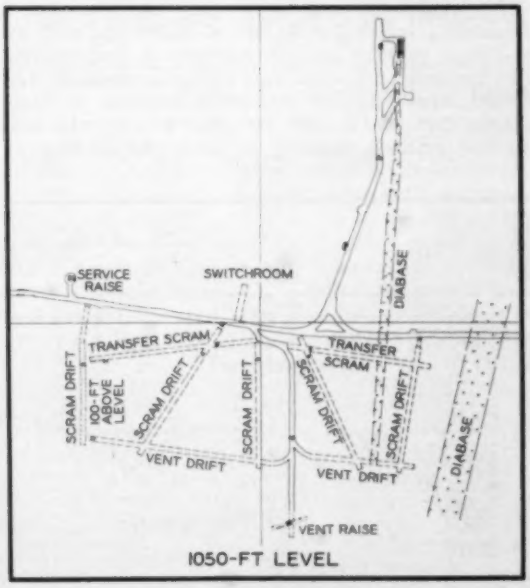
Scrams are driven 8 x 9 ft with a 2.5 to 4 pct grade

against the scraping direction, to drain all water away from the mill holes. Boxhole bases are staggered on opposite sides of the scrams from 25 to 30 ft apart and are driven 6 x 7 x 7 ft deep. The boxhole is driven up two rounds, 5 x 5 ft at 45°, except for one which is driven up three rounds to collar the undercut crosscuts. The 7 x 7-ft undercut crosscuts are driven 16 ft above the bottom of the scram and 18 to 20 ft from the center of the scram. From the undercut crosscuts the slot raise is driven vertically to the top of the mining block, and is located as nearly as possible on one side of the massive ore. From the opposite undercut crosscut a 5 x 5-ft box raise is driven up 30 ft and is connected to the slot raise by a 7 x 7-ft undercut slot drift driven 25 ft above the back of the undercut crosscuts.

It has required from 18 months to two years to develop a stoping block of about 4 million tons. At Geco, a foot of stope development is required for about every 110 tons of ore to be mined. As soon as one block begins stope development, exploration and mine development must be done to outline the third block, to have it ready for stope development before mining ends in the first block. This requires detailed scheduling of all work at least 18 months to two years ahead. General work schedules for exploration and mine development must be made at least five years in advance.

Level Plans



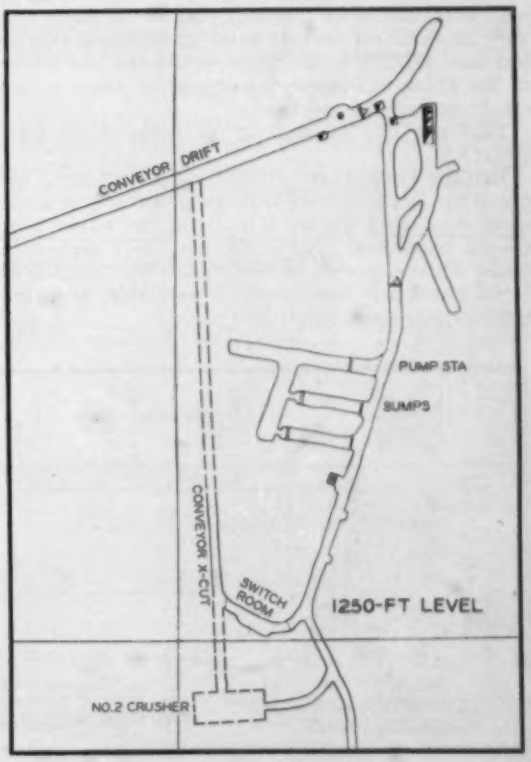


STOPING

Slots: The slot is placed as nearly as possible on one side of and at the contact of the massive ore. This makes it possible to control the grade to a certain extent by blasting either high grade massive ore or low grade disseminated ore after the slot has been mined. In making slots, hole distribution rather than powder concentration is the controlling factor. If it were economical to drill small holes, the powder concentration could be reduced, but it costs almost as much to drill a deep 1-in. hole as to drill a 2⅛-in. hole. Experience has indicated that an 11-ft wide slot with four holes in line and lines 4 ft apart is the most satisfactory. Three-hole slots with the slot only 8 ft wide would break if it were possible to keep the holes perfectly aligned, but a slight deflection off line of any of the holes can cause a bench to form. All holes are drilled to overlap 5 ft.

For slot work it is standard practice to blast two rows at a time, and whenever possible to blast the complete slot from top to bottom. Average powder factor for slots is approximately a pound per 10 cu ft of ore.

Undercuts: The undercut is essentially part of the normal ring pattern but is designed to be blasted separately—up to 25 ft ahead of the rings if necessary. The undercut forms two 55° troughs at the



bottom of the stope, with the broken ore forming the cones between the boxholes.

Undercut rings are spaced 4 ft apart with 10-ft toe burden, and the pattern is alternated from ring to ring. The 55° outline holes are drilled every 4 ft, to give a uniform bottom for funneling the ore to the scram. Opposite each boxhole extra holes are drilled beneath the 55° holes to get the broken ore down as close as possible to the scram. The ring is designed to have a minimum powder factor of 0.40 lb per 10 cu ft at the toes of the holes, and an overall powder factor of 0.7 lb per 10 cu ft for an average undercut blast. Tons per foot of drill hole amount to approximately 1.4. To prevent any sloughing at a brow that would be formed, the undercut is normally blasted with the rings. The undercut holes overlap the ring holes by at least 2 ft.

Stope Rings: Stope rings are drilled 8 ft apart with 9-ft toe burden, with about the same pattern for each ring. Holes are drilled from 90° up to 90° down, with hole lengths kept to a maximum of 75 ft to minimize deflection. Holes up to 100 ft long are drilled only to meet special conditions. Average length of ring holes is about 50 ft. Tonnage per foot of drill hole amounts to about 3.3 tons.

The ring is designed to have a minimum powder factor of 0.20 lb per 10 cu ft of ore at the toe, and an overall powder factor of 0.31 lb per 10 cu ft of ore for the ring. Rings are either blasted as one ring or several, depending on the amount of broken ore required. A vertical face is maintained if at all possible.

Pillar Rings: Pillar rings are laid out 8 ft apart with 9-ft toe burdens, with the same design specifications for minimum powder and length of hole as for the stope rings. Overall powder factor for a pillar blast is generally somewhat less than for the stope rings because the pillar has two free faces to break to instead of one. In pillar blasts the whole width of a pillar is blasted for the height required. Blasts will vary in size from several hundred thousand tons to less than 40,000 tons. To make certain that the center of the pillar is fragmented, the three rings at the center are capped identically.

Tons per foot of drilling for pillar work total about 4.8.

Drilling Equipment: All drilling for breaking the ore in the stopes is done with longhole carbide drills using four-wing 2⅛-in. bits. Drills are either 4 or 4½-in. percussion type drills, with 6-ft aluminum shells. Extension rods in 3, 4, 5, and 6-ft lengths of ⅞-in. hexagonal steel are made available. Standard rod charge is a 4-ft length.

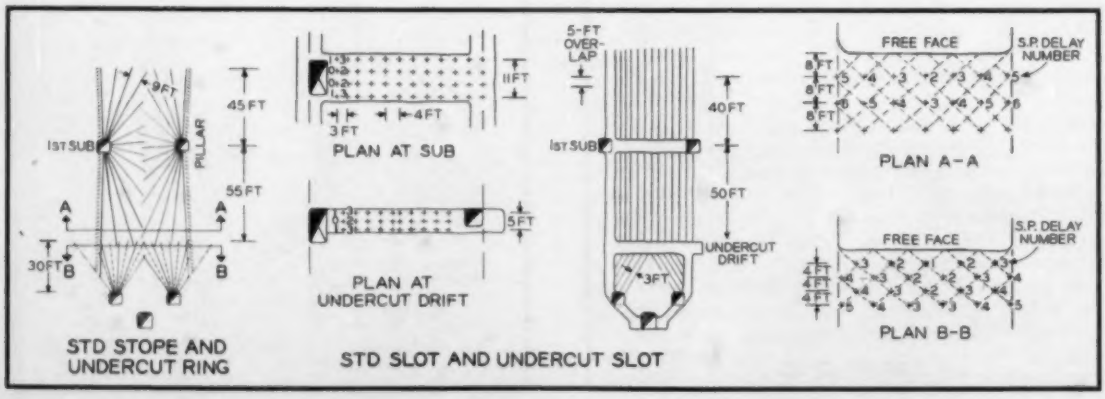
The drill is set up either between two columns on a short arm, or directly on one vertical column which is braced by another column set up crosswise to the drift. All set-ups have to be very solid for maximum drill efficiency. Two men generally work together to make the major set-up. The second man is either the drill foreman or a runner from an adjoining heading. Drills are operated by one man, who averages 130 ft per shift, including moving and set-up time. Shifts of over 200 ft have been achieved on ring drilling where there is a minimum amount of set-up time.

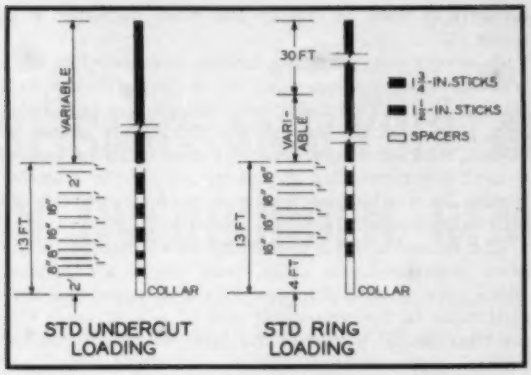
All holes are cased with 3-in. used boiler tube for at least 6 in. if the ground is broken up near the collar. The top of the casing is left extending above the hole at least 3 to 4 in., or high enough to extend above the sludge that will accumulate in the bottom of the drift. Upon completion each hole is tightly sealed with a turned plug. To keep the accumulation of sludge to a minimum, the up holes in a ring are drilled first, and before the drill is moved, all holes are flushed with water and blown clean.

Blasting: In designing the rings the theory was accepted that each hole should break out a triangle of ground with an angle of about 110° at the apex. Outline holes break out half as much as a hole in the middle of a ring. This pattern is achieved by using a toe spacing only slightly greater than the ring spacing. After the most economic size of hole has been decided the powder load per foot can be determined, and the hole and ring spacing fixed. For undercut drilling the same theory applies except that the split ring, or staggered ring, principal is used. The hole spacing is then approximately twice the ring spacing. To achieve the desired breaking pattern the rings are delayed internally with short period caps. Also, by doing this, the broken ore from one hole is forced against the broken ore from the opposite hole. The effect of peeling off a slab is avoided and a certain amount of attrition is achieved.

An attempt is made to arrange the firing order to use caps up to No. 8 only. Caps of a higher delay than this have a firing interval greater than 50 msec. Experience has proven that using higher delay caps does not give as good fragmentation and that the millisecond effect is lost to a certain extent.

The explosives used for primary blasting have a detonating velocity of 14,900 to 16,000 fps with an execution value of 245-259. For normal ring blasting and for undercuts and slots that are normally not loaded more than 24 hr before blasting, a semi-gelatin explosive is used. For pillar blasts, holes that are wet, or holes that will be loaded longer than 24





hr, a straight gelatin type of explosive is used. Explosives used are in the following cartridge sizes: 1½ x 16, 1¾ x 16, 1½ x 8, and 1¼ x 8 in., specially wrapped with perforated shells. For certain conditions the sticks are tapered.

Powder concentration is kept fairly uniform by standard load patterns that are used for different types of drilling (see illustration). For slot work the outline holes are loaded solid and the two inside holes are loaded with a 12-in. spacer between each gelatin stick. A 1-in. carlon flexible pipe with a wood tamping plug is used for placing powder in all down holes. The powder is tamped approximately every five sticks. For loading up holes Geco uses a plastic rod with a fast coupling every 4 ft.

All blasthole stope blasts are fired from a central system. Field lines are of No. 10 wire, made up in various lengths to connect the lead wires to the receptacles on the main blasting lines. Blasting lines are either No. 6 or No. 8 red neoprene jacketed copper wire, depending on whether they are used as main line or feeder line. Power is 550-v a-c current supplied from a 25-kva transformer, controlled by a blasting switch at No. 1 shaft collar house. Circuits are wired in series parallel with no series circuit having less than five caps or more than 50. All circuits are checked and balanced with a volt-ohm meter before any blast is initiated. To balance circuits, small resistors are used with intervals from 5 ohms to a maximum of 30 ohms. For large blasts the mine is cleared of all men, and supervisors check for dangerous gases—mainly CO—before the regular crews return to their working place.

ORE REMOVAL

Removal of the ore from the scrams is by 125-hp chain-driven two-drum slushers and 72-in. Eimco folding scrapers. Electric slushers of 60 hp with 60-in. folding scrapers are used for some stopes, which are recovering bottom ore fingers. Tail sheaves are of cantilever type, mounted on 18-in. I-beams. The sheave is 20-in. diam and has cast rope guides that will allow a square knot in the 1¼-in. rope to pass easily. The tail sheave is placed about 20 ft beyond the last boxhole and is mounted as near as possible to the back of the scram. These installations are very rugged and have been found to be self cleaning. The pull-back cable is supported on special 8-in. diam swinging blocks placed approximately every 50 ft along the back of the scram.

Mill holes are cut as nearly as possible to 4-ft diam with a vertical drop of 10 ft. They are lined with 12 cast liners, to form a 4-ft diam dodecagon. The slusher base is placed from 1 to 2 ft above the grade of the drift, and the mill-hole liners are placed about 2 ft below the drift grade. This helps prevent the scraper bail from knocking out the mill-hole liners.

Secondary blasting is done with explosive in 10-lb packages that can be broken up into 2½-lb packs; the agent is a desensitized semi-gelatin very similar to that used for primary blasting. The explosive is initiated with a small diameter detonating fuse and electric cap. By doing this a charge can be placed in a boxhole with minimum possibility of a rock fall initiating the blast. Several charges can be placed and fired with one cap. A single-shot hand blaster, or a blasting attachment on the cap lamp of the slusher operator, is used to fire the caps from a blasting station near the scram.

Accompanying tables give general data on efficiencies for the various stope operations.

VENTILATION

Ventilation is presently supplied by an exhaust system from the scrams, with fresh air entering the operating end of the scrams, and through the stopes from surface. Auxiliary ventilation by fans or

Table I. Blasthole Drilling and Primary Performance—January to August 1958

Type of Work	Feet Drilled	Man Shifts	Feet per Man Shift	Tons Drilled	Tons per Ft	Tons per Man Shift	Feet Blasted	Tons Blasted	Tons per Ft	Explosive, Lb	Explosive per Ton, Lb
Slots	4,725			5,250	1.10		25,605	27,050	1.05	28,630	0.985
Sills	25,357			37,930	1.50		57,997	74,474	1.29	51,400	0.690
Stope Rings	90,940			304,633	3.36		176,295	593,081	3.36	174,083	0.294
Pillar Rings	125,534			616,700	4.90		44,413	210,235	4.75	59,900	0.284
Total	246,556	1,898	130	964,513	3.90	507	304,310	905,440	2.98	312,073	0.345

Table II. Secondary Blasting and Ore Removal Performance

Tons removed	808,515
Man shifts in scrams and grizzlies	5,436
Tons per man shift	149
Explosive per ton, lb	0.22
Explosive, lb	177,472
Rope used, ft	21,785
Tons per foot of rope	37.2
Total explosive (including primary), lb	489,545
Total explosive per ton, lb	0.565
Primacord used, ft	909,500
Feet of primacord per ton	1.12

Table III. Mine and Plant Efficiencies

	Underground		Plant	
	Total Man Shifts	Tons per Man Shift	Total Man Shifts	Tons per Man Shift
Geco employes only	30,699.5	27.6	87,787,375	9.62
Including longhole contractors and diamond drillers	34,055.5	24.9	91,143,375	9.32

20-in. diam sheaves are rugged, self-cleaning.

Geco uses folding scrapers. Note swinging block at roof.

Mill holes are 4-ft diam, have cast liners.

blowers is used to supply the hoist operator with fresh air.

A severe air pumping action can develop in a transfer raise system such as is used for the first mining block. This frequently causes the mill holes that feed into the system on the lower levels to upcast, making the scrams very dusty. This problem is partially controlled by taking air off the transfer system on a lower horizon and by forcing fresh air in from behind the slusher operator.

The second mining block will be connected to the same main exhaust raise, with fresh air coming down through the stoping block and down the service raise to the operating end of the scrams. The ore pass layout prevents the problem of a pumping action.

The main exhaust fans are 48-in. axial flow type, completely reversible. As air requirements are increased, more units are added in parallel; and as the mine pressure increases, units are added in series. The main exhaust collar has been designed to take eventually four units in parallel, each unit having up to three fans in series, for a total of 12. The ventilation raise has been driven 12 x 10 ft to handle up to 175,000 cfm at approximately 4-in. water gage pressure. This makes it possible to purchase fan units only as they are required and to have complete flexibility to meet winter and summer needs. Total cost of all units is comparable to the cost of one large unit but the latter would not be able to produce the wide range of performance required. A long-term plan calls for reversing these units, thereby converting the present exhaust raise to a fresh air raise. This would require an exhaust raise at the east end of the mine for a true push-pull system to service the lower levels.

DRAINAGE

Drainage is mainly a problem of keeping the water made by open stopes and longhole drills from entering the main transfer raise system. To do this, all stope development headings are graded away from the planned mining face wherever possible, and all scrams are graded from 2 to 4 pct away from the mill holes. Any water that does get into the transfer raise system is collected by a drainage drift, beneath the main raise, on the 1050 level. A series of large diameter holes, drilled into the bottom of the ore pass, drain off the water and mud that accumulates. The drift is cleaned out with a scraper about once a week.

HOISTING

The hoists of No. 1 shaft are the first North American-designed and built Koepe-type winders, consisting of one 130-in. semi-automatic skip hoist with one 18-ton bottom dump skip and counterweight, and one 96-in. automatic cage hoist with a 40-man single deck cage and counterweight. The skip is loaded with a flood type measuring pocket located below the 1250 level. Hoisting rate at present is about 360 tph at most.

To date more than 1 million tons have been removed from six stopes and parts of the first three pillars. Mining has progressed as planned with efficiencies generally higher than anticipated. Adequate fragmentation and the movement of the ore from stopes to primary crusher by gravity through the transfer raise system and by conveyor to the loading pocket at the shaft were major factors in the achievement of these efficiencies.

SEISMIC ANALYSIS AIDS IN OVERBURDEN REMOVAL

The mine engineer or operator can determine easily, quickly, and inexpensively when to drill and blast and when to rip overburden for lower costs. By using seismic analysis he can put the right equipment to work for top job efficiency.

A fast, easy, and inexpensive method of determining the consolidation of overburden in surface mining operations through seismic analysis has been developed.

The method involves use of a refraction seismograph which measures overall consolidation of subsurface materials, including such factors as rock hardness, stratification or lamination, fracturing or jointing, and the degree of weathering or decomposition. It also is possible to determine the thickness of various layers of subsurface materials to depths exceeding 100 ft.

The only equipment needed is an 8-lb sledge hammer, a small steel plate, a coil of wire, a geophone receiver, the refraction seismograph, and a set of tables. Two men, after a minimum of training, can perform a seismic study in a matter of hours.

By this method the surface mine operator can determine rippability of the overburden material and, as a result, the most economical method of removing it: dozing and scraper-loading, ripping and scraper-loading, or drilling and blasting for shovel loading.

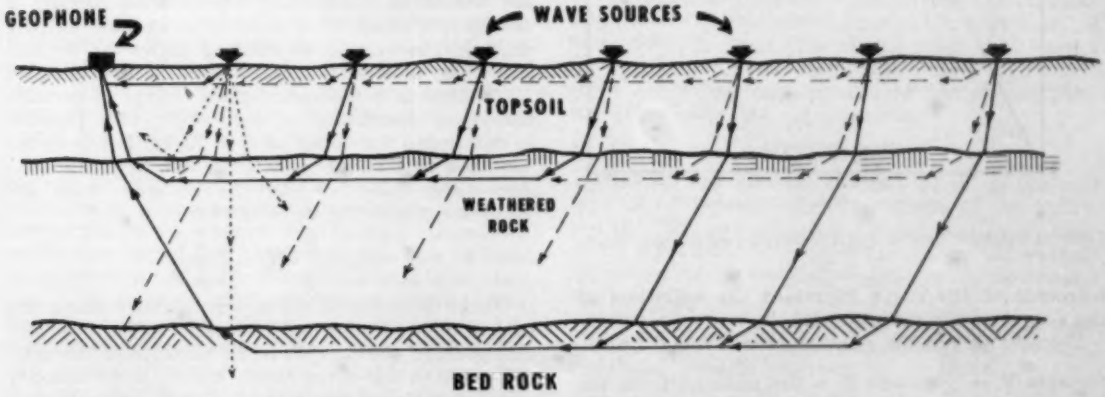
Engineers of Caterpillar Tractor Co. became interested in various methods of classifying subsurface materials with the development of heavy-duty tractor-mounted rippers several years ago. The company became convinced that on many jobs the use of rippers could reduce earth and rock-moving costs, lower production costs, and make possible larger profits for the mine operator.

The engineers found on job after job that where rippers could be used on a production basis, dirt could be moved at lower cost than by other methods.

Some examples of relative costs of ripping and of drilling and blasting on typical surface mining jobs are listed below:

Material	Ripping Production, Cu Yd Per Hr	Ripping Cost Per Cu Yd, ¢	Drilling and Blasting Cost Per Cu Yd, ¢
Limestone	250	7.3	17.3
Limestone	350	5.2	18.1
Sandstone	400	15.0	30.0
Limestone	400	6.5	—
Limestone	195	11.5	19.3
Sandstone	300	8.6	15.7
Frost	80	25.0	60.0
Paint Rock	330	6.1	34.5

These jobs include overburden removal and actual ripping of the quarried material. Note that the cost of loosening the material by ripping ranges from less than 12 pct to 60 pct of the cost of drilling and blasting. It should be further noted that these cost figures do not take into account the expense of moving the material. In most operations scrapers can be used to follow rippers, while shovels and trucks are used after blasting. Generally, this adds to the cost differential.



Seismic waves are created at the arrows, starting at a point 10 ft from the geophone and moving out 10 ft at a time to 100 ft. At 10 ft the wave near the surface is the first to reach the geophone. From 20 to 40 ft the wave traveling through the denser weathered rock reaches the geophone before the waves traveling through the less dense topsoil or the deeper bed rock. Beyond 40 ft, the waves traveling through the bed rock are the first to reach the geophone.

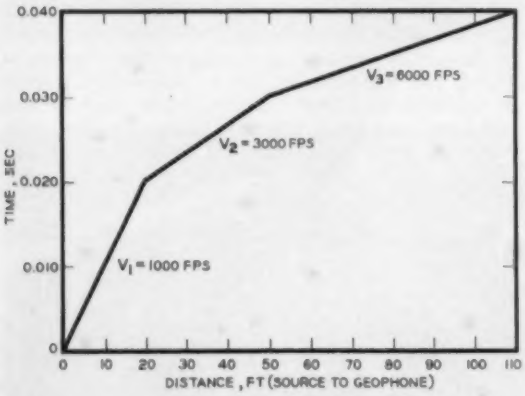
Methods currently used for determining rippability of overburden material were found by the engineers to be either inconclusive or too costly and time consuming. Core drills and hardness tests could provide some of the answers, but neither one nor both could completely determine whether or not ground could be ripped. Tests based on the electrical resistivity of subsurface materials were becoming more common, but required considerable core drilling and highly-trained, experienced personnel for accurate interpretation.

A search was made for something a user could handle with only a few days' training—something that would be relatively inexpensive. Introduction of the refraction seismograph for measuring overall consolidation of subsurface materials provided the answer.

The seismic wave is produced by a sledge hammer striking a steel plate at various distances from a geophone receiver. The receiver is sensitive only to the first seismic wave that reaches it. Thus, either the seismic wave that travels the shortest path or one that travels over a longer path, but which includes a high velocity segment, triggers the geophone. The time interval between hammer blow and receipt of the seismic wave at the geophone can be read directly on the instrument panel.

The solid lines in the accompanying diagram represent paths of the seismic waves which are detected by the geophone. Assuming for illustration that seismic wave velocities of the topsoil, weathered rock, and bedrock are 1000, 3000, and 6000 fps, respectively, it can be seen how the seismic waves traveling the longer paths can reach the geophone first. Dotted lines show the paths of seismic waves which have a longer travel time and, so, are not detected at the geophone.

Spacing of the seismic wave sources at 10-ft intervals permits construction of the accompanying graph of time vs distance. The slopes of the various



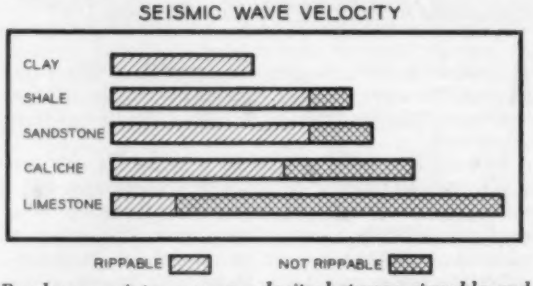
Time vs distance graph. Each material has its own slope.

segments of the curve represent the velocities of the seismic wave through each layer.

Velocity (V) of the seismic wave is found by the formula $V = \frac{D}{T}$ where D is the distance from the plate to the geophone and T is the time lapse.

These velocities can be used to determine ease of ripping of subsurface materials. An extensive program, recently completed, correlated performance of rippers with the consolidation of ripped materials as indicated by the refraction seismograph. The range of seismic velocities for common subsurface materials was obtained on construction and mining jobs where ripper performance was known. Over 200 tests were made in 18 states.

Typical results are shown on the accompanying bar graph. The graph shows the seismic wave velocities which indicate rippability in each material and also the higher velocities indicating material too dense or consolidated to be ripped. Work has progressed to the point where rippability of a dozen common materials can be predicted with reasonable accuracy. As more data is accumulated, evaluation of materials such as shale, sandstone, limestone, and caliche will be improved upon, and other materials will be added to the list.



Breakover point on wave velocity between rippable and non-rippable varies for each type of material. Separate tables must be compiled for each size of ripper. This one was developed for the Cat D9 with No. 9 ripper.

Actual analysis of the materials on a job is simple. From 20 to 30 min are required to run each test and to determine seismic wave velocities. A comparison of the wave velocities with those obtained in the same materials on prior jobs will give a good indication of the ripper performance and production that may be expected. Where this procedure has been followed, determinations of rippability have been remarkably accurate, Caterpillar engineers report.

It should be noted that the materials must first be classified as to composition, such as caliche, limestone, sandstone, or shale. Physical properties of different rocks vary in respect to their rippability even though velocities of sound waves through them are almost identical. Such classification usually is readily provided by a minimum amount of core drilling, observation of existing highwalls or outcroppings, or a general knowledge of area geology.

In addition to determining the degree of consolidation, or rippability, of each layer, it is possible to determine the depth of each layer. Depth is determined by a simple equation based upon the seismic wave velocities and the distance from the geophone where the velocity change occurs.

$$D = \frac{X_c}{2}\sqrt{\frac{V_2 - V_1}{V_2 + V_1}}$$

Where D is depth, X_c is the distance along the bottom of the line graph from zero to the intersection point of the line, V_1 is the velocity of the seismic wave in the upper layer, and V_2 is the velocity wave in the next lower layer. Depths of successive layers are determined in similar fashion.

The success of numerous seismic analyses conducted by the engineers indicates that expensive and complicated methods of classifying materials for overburden removal are no longer necessary.

BAUXITIZATION IN THE POCOS DE CALDAS DISTRICT, BRAZIL

by BENJAMIN N. WEBBER

During World War II the Pocos de Caldas bauxite deposits of Minas Gerais in Brazil yielded some 60,000 tons. Since then they have maintained a small but almost continuous production. Known for many years, the deposits have been reconnoitered by a number of geologists,[1-4] but no dimensional study has been possible because there have not been enough exposures to show clearly the depth, bedrock, and habit of occurrence.

The deposits are somewhat unorthodox in their occurrence mainly on steep slopes of mountainous terrain. Although the parent rocks are a sequence of alkalic intrusions that bauxitize readily under the proper conditions, bauxitization has not been the dominant weathering process in the area. It is limited to certain localities where important volumes of bauxite have formed by laterization of several rock types, each yielding a distinctive type of bauxite. Bauxitization may be observed in several stages and in both direct and indirect cycles of formation. The deposits are unique in being of demonstrably recent age, so that the conditions under which the bauxite formed are essentially those of the present time. The bauxitization sequence is postulated in Fig. 1.

Pocos de Caldas district is situated at approximately 21° 50′ south latitude and 46° 30′ west longitude in southwestern Minas Gerais, near its boundary with the state of São Paulo. It lies within the Eastern Plateau physiographic province of Brazil, occupying a prominent highland area that rises some 2000 ft above the surrounding country. The central portion of the Pocos de Caldas highland is characterized by gently undulating topography, with generally sluggish drainage, and is surrounded by a rim of hills rising above 1000 ft above it. In cross section the highland resembles a truncated cone with a depressed central area. The rim has been sculptured into a more prominent and abrupt topographic pattern than the central area, and streams that are of low to moderate gradient in the central plateau plunge over the rim in a spectacular series of cascades and falls.

B. N. WEBBER, Member AIME, is Chief Geologist, Mineração Hannaco Ltda., Belo Horizonte, Brazil. TP 4805 I. Manuscript, Jan. 9, 1959. AIME Trans., Vol. 214, 1959.

GEOLOGIC SETTING

The Pocos de Caldas highland owes its physiographic expression mainly to the differential erosion of a complex intrusion of alkalic rocks into gneiss and sandstone. Erosion was guided somewhat by faulting. The highland is almost circular, and its limits, except in one locality, coincide with the periphery of the intrusion. The alkalic intrusions largely control its shape and extent, aided by some subsidence through faulting of the central portion. The mountainous rim of chilled phase, the later intrusions, and the indurated intruded rocks have resisted erosion more effectively than the central portion of the intrusion, which is composed of more coarsely crystalline alkalic rocks that form a central basin in the highland. Gneiss and sandstone are found coincident in elevation with the topographically highest intrusions.

BAUXITE TYPES

Most of the bauxite, which varies in physical type, is on the top and steep slopes of the northern rim. The only alumina mineral is gibbsite, definitely crystalline but iron-stained unless of secondary origin. Clay particles occurring with the bauxite are kaolinite.

Some types of bauxite are an index to their origin. There are four general physical types of bauxite or bauxite laterite:

1) Surface Rubble: This partly nodular and partly fragmented type, usually less than 3 ft thick, results from surface weathering of massive bauxite or may form by superficial enrichment of nodular bauxite with a clay matrix when the interstitial clay is removed by surface runoff.

2) Massive Bauxite: This is light yellow, porous, cellular, and massive but friable. If it is derived by direct bauxitization of the country rock, it may show a phantom joint pattern inherited from the parent rock. The cells are reticulate and often show alignment similar to limonite silica boxwork in iron gossan; near the surface they may be lined with secondary crystals of gibbsite. This type of bauxite consists almost entirely of slightly iron-stained gibbsite with a small amount of residual kaolinite.

3) Nodular Bauxite in Clay Matrix: This consists of nodules, perdigon, and irregular aggregates of bauxite, some of which show a cylindrical stem-like form. These are disseminated through a matrix of, kaolinic clay. The bauxite fragments usually contain entrained clay or may be relatively pure gibbsite. The bauxite nodules may be accompanied by nodules of hard kaolin.

4) Replacement Pattern Bauxite: This type of occurrence consists of irregular aggregates of massive bauxite in a clay matrix. Both bauxite and clay aggregates may be several feet across and are highly erratic in distribution. This occurence suggests incomplete bauxitization of clay, with the bauxitization process spreading from replacement nuclei.

PARENT ROCKS

The alkalic intrusive rocks are consanguineous, with slightly variant mineralogy, including some unusual species. They have a notable range in texture—from dense, compact, aphanitic rocks to coarsely crystalline in which the crystals approach pegmatitic size. The range in crystal size suggests intrusion at different pressures and cooling rates. There probably was an important hiatus in time, particularly between the older and younger groups. The older intrusions are more coarsely crystalline and more intensely zeolitized than the younger group.

The following alkalic rock facies associated with bauxite were recognized. No regional study was made and these observations are confined to areas where commercial bauxite occurred. In order of increasing age, the younger group is as follows:

1) Phonolite: This is either an extrusion rock or a near-surface intrusion. It has a fine-grained aphanitic texture with a tendency toward layering which may represent flow structure. Its occurrence as observed is already limited, but it could be an important unit elsewhere in the highland. It is not lateritized and it overlies phonolite porphyry.

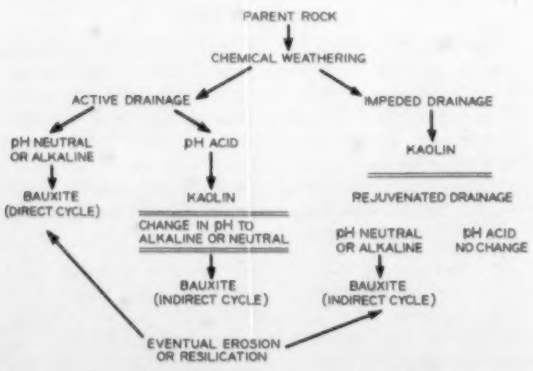


Fig. 1—Bauxitization cycles, Pocos de Caldas, Brazil.

2) Phonolite Porphyry: This is intruded in an irregular pattern into older alkalic rocks as well as the gneiss and sandstone. Parent rock of fully half the bauxite, it is characterized by abundant nepheline and alkalic feldspars. Femic accessories are mainly pyroxene with subordinate amphibole. No zeolitization was observed. Phonolite porphyry was the last intrusive phase of the alkalic rocks; it cuts all the other facies and penetrates the Botucatu' sandstone of Triassic age which unconformably overlies the Pre-Cambrian gneiss. This dates the last intrusion as post-Triassic, probably Cretaceous.

3) Nephelite Syenite: An important parent rock of bauxite, nephelite syenite contains the same minerals as the phonolite porphyry in about the same proportions. It preceded the phonolite porphyry, which cuts it with a sharp intrusive contact.

4) Nephelite Cancrinite Syenite: This consists of nephelite and alkalic feldspars in large crystals up to 3 in. long; it contains appreciable cancrinite in places and apatite and acmite as rare accessories. Occasionally a crystal of pyrite occurs. Zeolitization is apparent but not intense. Nephelite may be partly altered to analcite. This syenite is older than the phonolite porphyry that penetrates it. Its intrusive relation to the nephelite syenite was not encountered. It lateritizes readily to a low iron bauxite.

The older group of rocks is as follows:

1) Eudialyte Nephelite Syenite: This is a moderately coarse-textured intrusive rock consisting mainly of nephelite and alkalic feldspars and pyroxenes. Amphibole is less abundant than pyroxene. Eudialyte, euhedral zircon, and sphene are common accessories. The rock bauxitizes readily, yielding a product high in iron owing to the abundance of pyroxenes. The phonolite porphyry penetrates this intrusive, but the relation of this syenite to the other members of the alkalic group was not apparent in the limited area studied.

2) Gneissoid Eudialyte Nephelite Syenite: Essentially nephelite and feldspar, with abundant pyroxenes and considerable green amphibole, this rock has developed gneissic banding by parallel arrangement of tabular feldspars. Abundant femic minerals constitute about half the rock, generally occurring as augen around the feldspars. Eudialyte is usually a common accessory but in some localities is one of the principal minerals. Zircon and sphene are common accessories. Zeolitization is widespread. Zeolites developed are analcite and natrolite. Lack of metamorphic minerals other than zeolite belies the gneissic banding. Possibly the parallel arrangement of feldspars in augen of femic minerals results from crystallization under conditions of stress, so that the crystals tended to grow along lines of least stress. The rock lateritizes readily, with almost complete removal of silica except that contained in the zircon. Zircon remains inert to lateritization process and zircon crystals may be found in the laterite. Eudialyte breaks down completely, leaving residues of iron and manganese oxides. The lateritic end point of this rock is a ferralite or high-iron bauxite.

The rocks which have been intruded by the alkalic complex are an orthogneiss of granitic parentage and the Botucatu' sandstone. The gneiss forms bauxite on lateritization, but the free silica is unaffected; quartz crystals remain in the laterite.

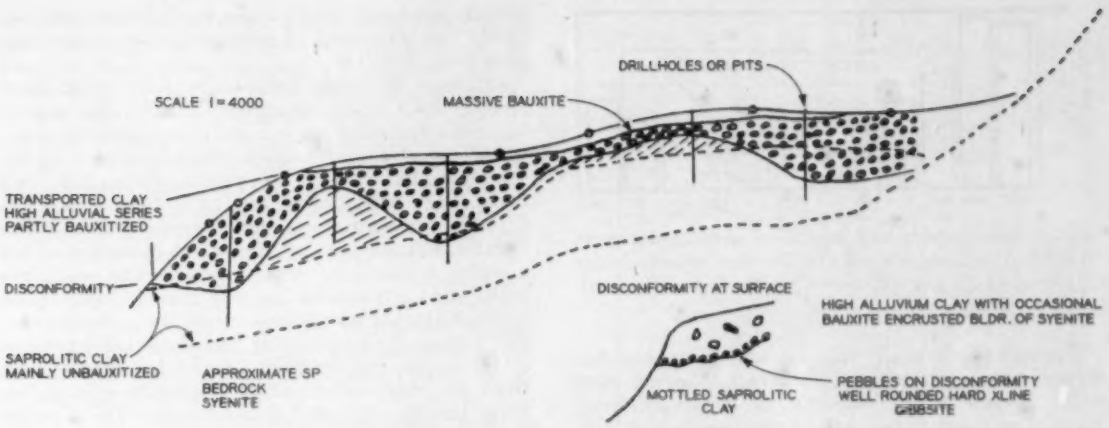


Fig. 2—Section along the disconformity between the high alluvials and the saprolitic clay. The inset at lower right shows the relation of bauxitization to disconformity between the high alluvium and the older saprolitic clay.

There is evidence that the alkalic intrusions have not been deeply truncated. Exposure is barely below the hood of the intrusive.

In addition to the igneous and metamorphic rocks that have yielded bauxite on lateritization, a very recent sediment has lateritized, which gives an index to the age of the bauxite. This is a high alluvium with a limited occurrence on stream terraces. It is composed of roughly stratified clay with small lenses of gravel and contains a lense of black clay whose color is due to particles of fixed carbon which ignite and burn at calcination temperature. This clay probably marks a local paludal condition at the time of deposition. The alluvium contains local accretions of outwash gravel and clay from the steel adjacent slopes. The drainage that deposited the bulk of the high alluvium is now entrenched about 50 meters below its former level. Drainage is entirely within the alkalic rocks and the sediments were all derived from the drainage basin. The high alluvium rests on saprolitic clay derived from alkalic syenite and in a few instances rests directly on the syenite. A disconformity between the saprolitic clay and high alluvium is a well-marked undulating surface with pockets and lenses of smooth water-worn pebbles consisting largely of hard crystalline gibbsite. The disconformity can usually be located in drillholes by an increase in bauxite due to the basal layer of gibbsite pebbles, followed by a change to saprolitic clay (Fig. 2).

AGE OF DEPOSITS

The significance of lateritization of the high alluvium is an index to the age of lateritization. The pebbles of gibbsite on the disconformity show that bauxite had formed and had been eroded before the high alluvials were deposited. Bauxitization of the high alluvials probably began when stream entrenchment reached a level where the terraces were well drained. The degree of lateritization of the high alluvials compares with that of several areas where igneous rocks or their saprolitic clays have lateritized.

Most lateritization in the district appears to have taken place after the drainage had been subjected to some rejuvenation and had been lowered to almost its present level. This is geologically recent and bauxitization is in process in some localities at the present time. The recent age makes it unnecessary to infer the conditions at the time of bauxitization. They are essentially those now existent in the region, with the exception of the foremost cover.

FEATURES CONDITIONING BAUXITIZATION

Climate: The alternate wetting and drying favorable to bauxitization are characteristic of this area, not only seasonally as evidenced by the distribution of rainfall (Fig. 3), but also because there are steep slopes and rapid drainage after every storm. Annual precipitation is 90.87 in. Rainfall on the highland rim is believed to be appreciably higher than that shown but is subject to the same periodicity. Masses of moisture-laden air collide with the highland rim and drop a considerable portion of their moisture before reaching Pocos de Caldas, and it is the higher elevations of the peripheral hills that are most extensively bauxitized.

Climate throughout the year is temperate, bordering on the subtropic. The following record for 1957 was obtained through the courtesy of the Ministry of Agriculture, Meteorologic Service:

Average Monthly Daytime Temperatures, °F, 1957

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
69.8	68.8	68.0	65.0	60.0	59.0	57.2	62.6	64.1	69.4	67.8	70.7

Minimum recorded 46°; maximum recorded 79.9°.

Average Monthly Humidity, Pct, 1957

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
80.7	82.1	80.7	81.9	77.6	77.7	76.4	71.8	77.4	76.1	79.5	80.3

These climatic conditions favor chemical reactions and bacterial activity.

Permeability: Porosity of the aphanitic phonolite porphyry is low. The syenites have a somewhat higher penetrability, owing to the size of the crystals of silicate minerals. Both are about equally jointed and rock joints are the major points of attack for pluvial water. Along occasional faults where the rocks were shattered there is a great increase in permeability. The footwall of one noted fault is unbauxitized, whereas the hanging wall side is bauxitized to a depth of 30 ft.

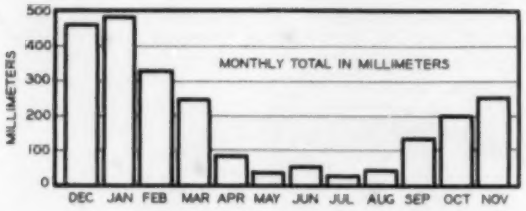


Fig. 3—The quantity and frequency of precipitation in the Pocos de Caldas district of Brazil as observed over a period of 19 years. (Servico Meteorologico Paulista).

Vegetation: Undoubtedly human occupancy has altered the vegetation pattern, which is highly variable. Heavy forest remains in some localities, mostly on steep slopes; others are open grass land. In the areas now occupied by forests there is some accumulation of humus, but the balance between micro-flora and macro-flora usually does not permit more than a foot of humus to accumulate. On the steep slopes, where most of the bauxitization has occurred, there is enough rainfall to flush most of the soluble humic compounds into the drainage.

Drainage and Erosion: Topographic relief of the bauxite deposits is pronounced, with elevations from 4000 ft at the base of the mountain rim to 5500 ft at its crest—a variation of 1500 ft in less than a mile. The steepness of slopes which have been bauxitized is notable; statistics show a minimum of 5° and a maximum of 27°. The average slope of bauxitized terrain is 18°, far from the near-peneplain conditions or topographic maturity of most laterite formation.

Topographic relief and rapidity of drainage apparently favor bauxite formation, but the critical factor is preservation of bauxite rather than its formation.

The physiographic surface is gradually being modified, a process that probably began when the alkalic rocks were first exposed. In some localities erosion has kept pace with bauxitization, but in many places it has proceeded more slowly. On the higher slopes where most of the bauxite occurs, runoff is partially impeded by vegetation. Much of it seeps through that portion of the bauxite that is highly porous, but only after saturation has been reached. This lessens erosion by rainfall and facilitates removal of the soluble products of rock decay.

The depth of secular decay is highly variable over the area of bauxitization, ranging from nothing over rock outcrops to a maximum of 65 ft and averaging 33 ft. Out on the central plateau where erosion is less active and drainage more sluggish, hydrolization to kaolinic minerals is the dominant process, although alkalic rocks predominate and rock decay has extended to greater depths, often approaching 100 ft.

Influence of Parent Rocks: The parent rocks have already been briefly described. Most of the bauxite has been derived from phonolite porphyry and nephelite syenite, and there is little difference in the chemical character of the bauxite from these two rocks. Each of the other five units from which appreciable amounts have been derived yields a distinctive bauxite that is a chemical reflection of the mineral components of its parent. The eudialyte rocks yield a high-iron bauxite, which indicates the relative abundance of femic minerals in these rocks. The titania content reflects the appreciable sphene, and the low iron content of the bauxite derived from the cancrinite-bearing nephelite syenite reflects the sparsity of femic minerals. The bauxite derived from high alluvials reflects the origin of the high alluvials, which were in turn derived from phonolite porphyry and nephelite syenite. The bauxite derived from gneiss was incompletely analyzed but reflects the free silica of the component gneiss (see Table I).

BAUXITIZATION

Bauxitization has been accomplished by a direct and an indirect cycle. The direct cycle is bauxitization of country rock with no intermediate stage. The indirect cycle shows an intermediate clay stage, during which the country rock was kaolinized and the kaolin later desilicated to form bauxite. In chemical character there is little difference between bauxite derived directly from the parent rock and that which went through a saprolitic clay stage before bauxitization.

Statistics from a large number of exploration openings show that 65 pct of these openings bottom on clay underlying bauxite and 35 pct on rock. These figures are considered a good index to the relative amount of bauxite which went through a preliminary clay stage and indicate that only about one third of the bauxite was directly derived from country rocks.

Evidence of direct bauxitization may be found in many exploration openings where bauxite with practically no clay content bottoms on bedrock and bauxitization extends into the joints of the bedrock, making a microscopically sharp contact of bauxite to rock. As shown in Fig. 4, these exploration exposures have a typical chemical profile from top to bottom, with practically no variation in bauxite or clay content to suggest that a clay stage ever existed.

Indirect bauxitization is evidenced by a larger number of openings which show a downward transition from massive bauxite at the top to a mixture of bauxite aggregates in clay, the clay content in-

Table I. Comparison of Bauxite Derived from Various Rock Units

Percent	Phonolite Porphyry	Syenite	Eudialyte Nephelite Syenite	Gneissoid Eudialyte Nephelite Syenite	Cancrinite Nephelite Syenite	High Alluvium	Ortho-Gneiss
LOI	27.08	27.55	25.00	24.05	29.18	27.68	—
Insol.	3.92	4.46	4.9	5.39	5.50	6.55	12.00*
Fe_2O_3	8.62	8.81	16.4	21.43	6.60	8.00	9.00
TiO_2	0.86	0.88	1.7	1.63	0.60	0.80	—
Al_2O_3	58.59	58.36	49.5	47.83	57.90	57.10	50.34

* Approximately 6 pct free SiO_2.

creasing and the bauxite content decreasing downward through bauxitic clay to clay bedrock. In some of these holes, bedrock was reached that is hydrolizing to clay minerals. The chemical profile of the hole shows a distinct relation of clay to bauxite which varies directly with depth. Kaolinization, apparently the first process, is still under way. In the upper and better drained portion of the profile bauxitization has proceeded to completion by desilication of clay and is advancing downward as a function of time and drainage, its intensity varying inversely with depth. A few instances were noted in which the clay gradient indicated changes from the usual profile. The profile in the upper portion of the hole indicated desilication of clay and in the lower portion direct bauxitization of country rock. Statistically only 4.2 pct of the exploration openings reveals an abnormal chemical profile differing essentially from those illustrated. Where clay has been desilicated to bauxite, the process of bauxitization is almost invariably more complete near surface (Fig. 4).

No instances were noted in which direct bauxitization of country rock had changed to kaolinization, though conceivably this would happen if an active drainage became rapidly stagnated.

The many iron analyses of bauxite plotted against depth show no appreciable variation in iron content with depth. This lack of iron mobility during bauxitization is attributed to a neutral or alkaline environment with an abundant supply of oxygen, conditions under which ferrous compounds are rapidly oxidized and become relatively fixed as sesquioxides.

Those changes in the bauxite which have taken place after bauxitization was completed are of minor volumetric importance and are best observed in massive bauxite. There is evidence of some solution, migration, and reprecipitation of alumina, and in certain instances tiny veinlets of hard crystalline gibbsite reticulate massive bauxite. These show a tendency to follow the phantom jointing of the bauxite, which is a partial preservation of the original jointing of the parent rock. The cells in porous cellular bauxite often contain secondary gibbsite crystals. In the surface rubble overlying massive bauxite, concretions of almost pure, hard, crystalline gibbsite occur which tend toward a turnip shape with a hole or other evidence of a central conduit on the long axis. In place, they always point downward. Some of these are intricately plicated, showing growth by accretion.

Resilication of bauxite is suggested by clay veinlets cutting massive bauxite. Like the secondary gibbsite veinlets, these tend to follow the phantom jointing, though not invariably. Replacement of bauxite by clay may spread from the phantom joints, leaving unreplaced massive bauxite in the center of the phantom joint block.

Chemical weathering predominates over mechanical weathering throughout most of the district. Hydrolization of rocks to kaolinic products is the predominating process. Direct bauxitization and kaolinization are both in progress, occasionally in the same general locality.

Drainage is an observable control, both in direct bauxitization of country rock and bauxitization of clay. In an environment of impeded drainage the weathering product is always clay. Under conditions of active drainage, either kaolinization or direct bauxitization of country rock may occur. Direct

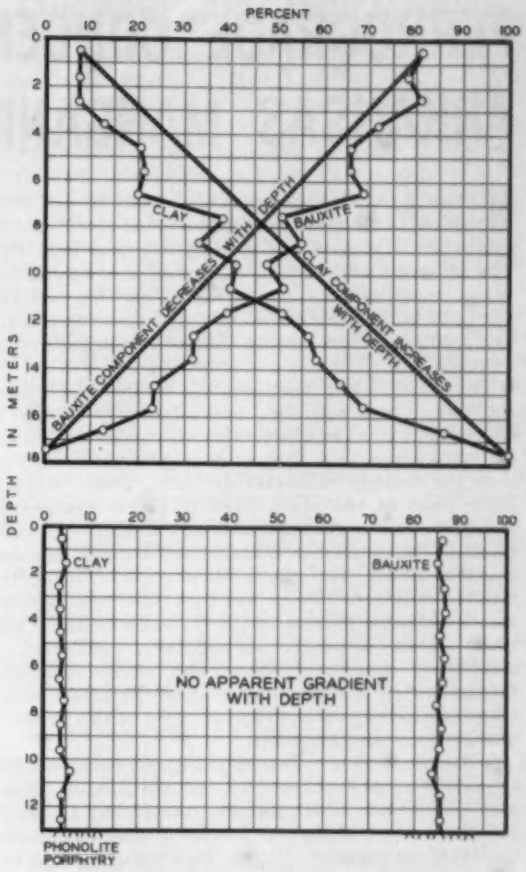


Fig. 4—Typical bauxite and clay variation with depth. Clay and bauxite calculated from analyses. ABOVE: Bauxite which is derived from the desilication of clay. BELOW: Bauxite derived directly from parent rock.

bauxitization is here considered to result from a favorable pH. A slight increase in acidity results in kaolinizaton. The role of pH may be oversimplified, since the conditions under which alumina and silica react to form clays are subject to complicated controls. The conditions under which silica may remain in solution and be removed, though unsual in nature, appear to be chemically simpler. Kaolin once formed under the existing climatic controls is subject to bauxitization, if the drainage remains or becomes active. Bauxite, regardless of direct or indirect origin, is subject to both enrichment by secondary gibbsite and resilication to clay. Both processes can be observed but are considered volumetrically unimportant.

The writer is indebted to J. K. Gustafson, vice president and director of exploration of Hanna Mining Co., for permission to publish data obtained during exploration of these deposits.

REFERENCES

[1] E. C. Harder: Examples of Bauxite Deposits Illustrating Variations in Origin. *AIME Trans.*, 1951, vol. 193.
[2] E. C. Harder: Stratigraphy and Origin of Bauxite Deposits. *61A*, 1949, vol. 60.
[3] M. de S. Pinto: Bauxite em Pocos de Caldad. Bull. 23, 1938, Dept. Nacional de Producao Mineral.
[4] T. de S. Santos: Contribuicao da Congr. Sul. Amar. de Chem. Inst. Pengrica. Bull 17, 1937.

Discussion of this article sent (2 copies) to AIME before Sept. 30, 1959, will be published in MINING ENGINEERING.

FERROGRADE CONCENTRATES FROM ARKANSAS MANGANIFEROUS LIMESTONE

by M. M. FINE

Normally the U. S. produces less than 10 pct of its annual manganese requirement. About 95 pct of domestic consumption is used by the steel industry.[1] The strategic and critical nature of manganese has been recognized by its inclusion in the national stockpile and by intensified research directed toward cataloging and evaluating domestic manganiferous deposits.

The USBM has participated in these activities for many years with field and laboratory studies to assess the extent and potential utilization of domestic manganese ores. One area of particular interest is in the vinicity of Batesville, Ark., where deposits have been mined since 1849 for both manganese and ferruginous manganese ores. Production is centered in Independence County, but deposits are also found in Sharp, Izard, and Stone counties in north-central Arkansas. Miser has described the geology and manganese mineralization in some detail.[2, 3] The rocks of the area are sedimentary, consisting of sandstone, limestone, shale, and chert. The two formations of greatest importance,[4] Fernvale limestone and Cason shale, are host rocks of the primary manganese mineralization.

Through 1955 the district produced some 230,000 long tons of manganese ore (35 pct Mn or more) and 236,000 tons of ferruginous manganese (10 to 35 pct Mn).[5] Most of the ore has been mined from deposits of manganese oxides in residual clays resulting from weathering of the two formations noted above. Concentration methods have been primitive, consisting for the most part of washing, hand picking, and jigging.

A significant accomplishment in the district in recent years was the USBM recognition and investigation of the huge manganese potential represented by unaltered Fernvale limestone. Systematic reconnaissance of manganiferous limestone and other occurrences has been in progress since 1953 to delineate the extent and tonnage of manganiferous materials. Results of that survey have appeared in two recent publications,[4, 5] which ascribe to the district an inferred reserve of 166 million long dry tons at a grade of 5 to 6 pct Mn. Most of this was manganiferous limestone with an estimated content of 5 pct Mn.

Specifications: Beneficiation was carried out on a group of manganiferous limestones to develop a way to recover commercial-grade concentrate from this extensive resource. The following chemical specifications were established by the GSA for metallurgical manganese ore acceptable for delivery to the national stockpile:

Constituent	Percent by Weight, Dry Basis
Mn	40.00 minimum
Fe	16.00 maximum
SiO_2 plus Al_2O_3	*
P	0.30 maximum
Cu plus Pb plus Zn	1.00 maximum**

* No limit specified, but material over 15 pct will be purchased in exceptional cases only.
** Of which not more than 0.25 pct may be copper.

Size specifications were not considered, as it was assumed that the concentrates could be pelletized or sintered.

Manganiferous Limestones: Of the 11 samples tested to date, six were taken by cutting vertical channels across beds of limestone outcrops. Diamond drilling through overlying barren chert into unexposed limestone provided four samples, and the last was a churn drill sample. In general, the samples were dark, fossiliferous limestone containing small amounts of braunite, hausmannite, rhodochrosite, massive and micaceous iron and manganese silicates, quartz, barite, and glauconite. The braunite and other manganese oxides partly to completely replaced some of the calcite and fossil material. The calcite was generously stained with mangenese and iron oxides. Phosphorus was present in all samples as collophanite grains, calcium phosphate fossil replacements, or an unidentified manganese-bearing carbonate.

The difficulty in separating this complex array of minerals was further complicated by a very intimate association. Although some manganese grains as large as ⅛ in. were noted, grinding to subsieve sizes would have been necessary to liberate the components. Figs. 1 and 2 are micrographs, at X100, of typical polished sections in which white areas are manganese, gray is gangue, and black areas are surface depressions. By comparison with the 100 mesh opening, it is seen that some of the grains are coarse enough to respond, perhaps to tabling or flotation, but many are obviously beyond the scope of physical processing.

Partial chemical analyses of the eight samples that were ultimately amenable to concentration are presented in Table I.

BENEFICIATION RESEARCH

Tabling: To take advantage of the presence of sand-size grains, both jigging and tabling were considered at the outset. Jigging was largely ineffective, but tabling achieved a partial recovery from most samples. As an example, the surface material from Baxter Hill was crushed to −28 mesh, hydraulically classified, and the coarsest spigot fraction was tabled to yield a concentrate, middling, and tailing. The latter two were reground to pass 48 mesh, combined with the primary fines, reclassified, and retabled. The middling and tailing were again ground, this time to pass 150 mesh, and deslimed at 20μ in a 3-in. hydraulic cyclone. The cyclone underflow was returned to the table to reclaim a small amount of high-grade manganese.

An interesting facet of the gravity concentration developed on certain samples in which braunite was the principal manganese constituent. Since braunite has a Mohs hardness of 6 to 6.5, while the host rock, limestone, is only 3, a differential size reduction took place during crushing, and the

M. M. FINE, Member AIME, is Supervising Extractive Metallurgist, Region IV, U. S. Bureau of Mines, Rolla, Mo. TP 59B25. Manuscript, Oct. 14, 1958. San Francisco Meeting, February 1959. AIME Trans., Vol. 214, 1959.

coarsest fraction became enriched in manganese. However, at this the size (about 28 to 48 mesh) many manganese grains were still locked and on subsequent tabling reported in the middling along with finer gangue. Screening this middling on 40 to 48 mesh, it was found, recovered up to 15 pct of the total manganese. The screen product was of lower grade than the conventional concentrate, but the two could usually be blended.

Table II presents the results of tabling the Baxter Hill surface ore. More than 40 pct of the manganese was recovered in a product acceptable in all respects other than phosphorus.

Flotation: Flotation was included in the flowsheet as a scavenging operation to capture some of the fine manganese remaining in the cyclone overflow and table rejects, which still accounted for 59.1 pct of the total manganese at a grade of 3.5 pct Mn. It was recognized that much of this, in the form of dustlike inclusions in limestone, was unrecoverable manganese.

A double-flotation scheme was devised which recovered about one third of the remaining manganese at a usable grade. The combined table rejects were pulped with zeolite-softened water, charged to a flotation cell, and conditioned with caustic soda to disperse the slime and with corn dextrin to retard flotation of the braunite. Most of the limestone was then floated with a tall oil fatty acid and cleaned once. The cleaner and rougher tailing were combined, settled, and deslimed at 10μ by decantation. The settled sand was then refloated to reject most of the remaining limestone, leaving the manganese as the nonfloat product.

Table III details the results typical of floating Baxter Hill table rejects. Note that 34.0 pct of the manganese in the feed was recovered at a grade of 25.3 pct Mn. Though low, this was adequate, as will be shown later. For reasons already discussed, the flotation step is inefficient from a metallurgical standpoint. From an economic standpoint flotation of the gangue rather than the manganese minerals is also undersirable, as it is necessary to bring about 90 pct of the bulk into the froth to recover the much smaller amount of manganese. However, many experiments failed to indicate a satisfactory method for reversing the procedure. Quebracho, under other circumstances a potent depressant for calcite, in this instance had very little effect on the limestone but did retard manganese flotation. Other reagents like sodium silicate and soda ash will depress manganese oxides in the presence of limestone, but starch products seem best for this purpose.

Leaching: At this stage, combining the table and flotation manganese products had achieved a recovery of 61.0 pct at a grade of 34.4 pct Mn, 9.9 pct Fe, 11.3 pct acid insoluble, and 0.53 pct P, but the product was still submarginal. Final upgrading was effected by a dilute-acid leach that removed enough phosphorus and limestone to raise the manganese to an acceptable value. Leaching was conducted with 2.5 pct sulfuric acid for 1 to 2 hr at room temperature. The leached product was washed twice with 25 to 50 volumes of water, dried, and ignited.

SUMMARY AND CONCLUSIONS

An extensive low-grade occurrence of manganiferous limestone in Arkansas has been studied by the U. S. Bureau of Mines as a possible source of manganese ore. Laboratory research on samples from surface exposures and churn and diamond drill cores developed a beneficiation process comprising tabling, flotation, and leaching applicable to 8 of the 11 samples studied. From feed materials analyzing less than 5.0 pct Mn, ferrograde concentrates of 41.7 to 49.5 pct Mn were achieved at 48.2 to 66.0 pct recoveries.

In view of these results, Arkansas manganiferous limestone is considered a potential source of metallurgical manganese ore. The following conclusions are guides to examination and treatment of manganiferous limestone:

1) Grade is much less important than mineralogical composition.

2) Samples containing substantial amounts of rhodochrosite, in addition to manganese oxides, are unlikely to respond to processing.

3) Soft manganese oxides and those in which iron constitutes an appreciable content of the mineral are not easily separable from limestone gangue, and resulting concentrates will be submarginal.

4) Ores in which braunite and/or hausmannite are the principal manganese minerals are likely to be concentratable.

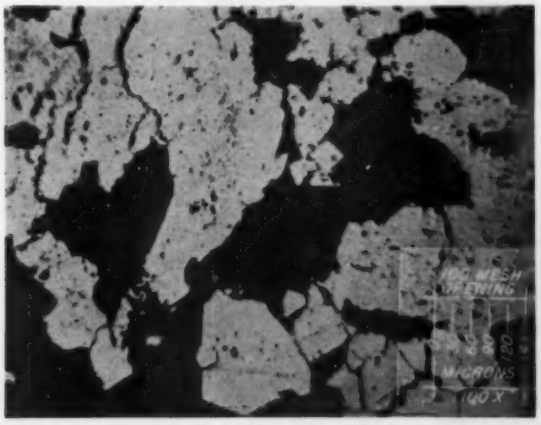


Fig. 1—Manganiferous limestone showing coarser manganese. X100. Reduced about one fourth for reproduction.

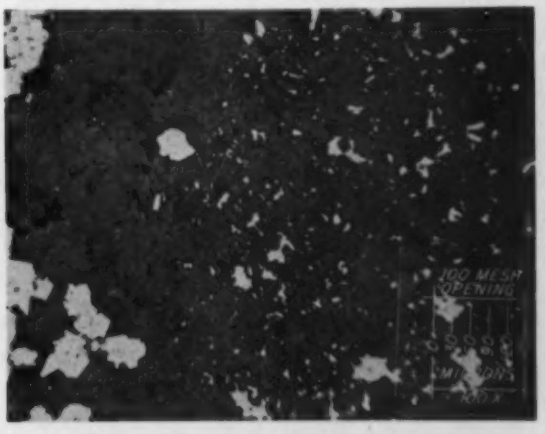


Fig. 2—Manganiferous limestone showing fine manganese. X100. Reduced approximately one fourth for reproduction.

The final product analyzed 42.4 pct Mn, 12.1 pct Fe, 12.5 pct SiO_2, 2.0 pct Al_2O_3, 0.21 pct P, and 0.36 pct S, which meets the specifications given earlier. Less than 2 pct Mn was lost by solution, so final recovery amounted to 59.2 pct. Acid consumption came to 0.15 lb of H_2SO_4 per pound of concentrate or 22.7 lb per ton of crude ore. These figures would fluctuate with efficiency of limestone rejection in both tabling and flotation. Although the exact wash water requirements were not determined, much water would be needed, since calcium sulfate is the principal reaction product in leaching.

Residual sulfur in the concentrate is partly accounted for by the limited solubility of calcium sulfate and partly by the presence of barite in the ore which must concentrate to some extent with the manganese. Gangue sulfates are not uncommon in manganese ores,[6, 7] and small amounts of barite are tolerated in metallurgical ore.[8] Hence minor quantities of barite and calcium sulfate in the products of this investigation are not expected to lessen their potenial value as metallurgical manganese ore.

Other Samples: The experimental procedure detailed above is the maximum processing accorded any sample. Table IV summarizes respective concentrate grades and recoveries of all samples, analyses of which are given in Table I.

Although the basic flowsheet described above was followed, differences in mineralization and improvements in technique permitted simplifications. For example, certain table tailings and cyclone slimes (either or both) from samples 2, 3, 6, and 8 were discarded immediately without being routed to flotation. Sample 8 was tabled at −20 mesh, and clean tailings were rejected at that size. Sample 4 yielded concentrates low enough in phosphorus so that leaching was unnecessary.

The three samples not amenable to concentration were a drill core sample from Reeves Hill, a surface sample from Miller-Rhinehart property, and churn drill cuttings from Greenfield Hill, all in Independence County, Ark. All contained 5.0 to 5.7 pct Mn, but the mineralization was such that satisfactory beneficiation by mechanical processes was impossible.

Byproduct: A considerable amount of crushed Fernvale limestone is sold in the Batesville area for agricultural purposes, so it is possible that table and flotation tailings similar to those created in this investigation may have potential value. The limestone is a high-calcium type, as shown in the Table V analyses of two random products.

Table I. Manganiferous Limestone Head Samples

Sample No.	Property	Type of Sample	Analysis, Pct Mn	Fe	Insol	P
1	Baxter Hill	Surface	5.4	2.7	2.4	0.31
2	Baxter Hill	Cores	3.5	2.9	2.2	0.39
3	Chinn	Surface	4.5	1.2	2.0	0.22
4	Chinn	Cores	3.6	4.6	1.9	0.24
5	Adler	Surface	7.7	1.9	2.1	0.32
6	Vanemburg	Surface	5.2	1.3	3.9	0.24
7	Thompson	Surface	4.6	2.0	1.6	0.26
8	Arkansas Mining & Exploration Corp.	Cores	4.5	2.5	2.2	0.25

Table II. Results of Tabling Baxter Hill Surface Ore

Product	Weight, Pct	Analysis, Pct Mn	Fe	Insol	P	Percent of Total Mn
Concentrate	5.5	41.5	7.7	6.5	0.50	40.9
Middling	6.6	7.2	3.4	2.0	0.50	8.5
Tailing	53.2	3.0	1.8	1.6	0.21	28.2
Slime	34.7	3.6	2.4	2.4	0.29	22.4
Composite	100.0	5.6	2.4	2.1	0.27	100.0

Table III. Flotation of Baxter Hill Table Rejects

Metallurgical Data

Product	Weight, Pct	Analysis, Pct Mn	Fe	Insol	P	Percent of Total Mn
Limestone 1	85.5	1.6				40.0
Limestone 2	5.0	8.3				12.1
Manganese	4.6	25.3	12.6	17.4	0.58	34.0
Slime	4.9	9.7				13.9
Composite	100.0	3.4				100.0

Operating Data

Reagent	Pounds Per Ton of Feed: Conditioner 1	2	Rougher 1	Cleaner	Conditioner 3	4	Rougher 2
Caustic soda	2.5						
Dextrin 152*	1.0			0.5	0.125		
Aliphat 44E**		0.32					
Soda ash							
Sodium oleate						0.20	
pH		10.1				9.2	
Time, min	5	5	8	6	5	5	8

* Corn Products Refining Co.
** General Mills Inc.

Table IV. Concentrates and Recoveries

Sample No.	Analysis of Concentrate, Pct Mn	Fe	SiO_2	P	Recovery, Pct Mn
1	42.4	12.1	12.5	0.21	59.2
2	42.9	9.7	12.5	0.09	48.2
3	45.2	8.0	14.0	0.15	60.6
4	45.7	5.5	6.9	0.26	56.1
5	45.5	7.0	5.3	0.11	58.9
6	49.5	2.9	12.2	0.08	62.3
7	41.7	9.0	8.1	0.11	66.0
8	46.0	8.1	9.1	0.14	51.4

Table V. Analysis of Limestone Products

Product	Analysis, Pct CaO	MgO	SiO_2	P	Fe	Mn
Table	51.9	0.22	0.56	0.16	1.2	1.3
Flotation	45.9	1.4	2.0	0.33	3.5	1.6

REFERENCES

[1] G. L. DeHuff: Manganese, a Chapter from Mineral Facts and Problems. *USBM Bull. 556*, pp. 493-509, 1956.
[2] H. D. Miser: Deposits of Manganese Ore in the Batesville District, Ark. *USGS Bull. 734*, 1922, 273 pp.
[3] H. D. Miser: Manganese Carbonate in the Batesville District, Ark. *USGS Bull. 921A*, 1941. 97 pp.
[4] H. D. Kline and J. P. Ryan: Manganese Resources of the Batesville District. Ark. Interim Report I, *USBM R. I. 5206*, 1955, 40 pp.
[5] H. D. Kline and W. F. Brown: Manganese Resources of the Batesville District, Ark. Part II of three parts, *USBM R. I. 5411*, 1958, 46 pp.
[6] A. M. Bateman: *Economic Mineral Deposits*, 2nd ed., p. 581. John Wiley & Sons Inc., New York, 1950.
[7] S. J. McCarroll: Upgrading Manganese Ore. *AIME Trans.*, 1954, vol. 199, p. 289.
[8] *Materials Survey—Manganese*, chap. 1, p. 12. USBM and USGS, October 1952.

Discussion of this article sent (2 copies) to AIME before Sept. 30, 1959, will be published in MINING ENGINEERING.

MARKET TRENDS FOR MINERAL FILLERS IN WESTERN STATES

by WALDEMAR F. DIETRICH

Mineral fillers are relatively inert chemically under the conditions of use but have physical properties* that modify those of the materials in which they are incorporated.

* The properties, uses, and other data on 15 classes of important fillers are listed in the second edition of *Industrial Minerals and Rocks*.[1] A third edition of this reference is in preparation.

The mineral fillers considered in this article are asbestos, barite, clays, diatomite, crushed limestone, limestone whiting and lime, mica, silica, talc and soapstone, and pyrophyllite. Slate and stone, other than limestone and its derivatives, are excluded because, even though used in large quantities, they are exceptionally low-cost materials generally produced close to the area where they are used.

Carbon black is excluded because it is manufactured from natural gas and more than 90 pct of the output is used in rubber; hence the factors for estimating requirements are easily evaluated.

OVERALL GROWTH FACTORS

Table I gives the population, retail sales, and value added by manufactures in the U. S. and in the eleven western states in 1954. These data are rough guides to the proportionate part of total U. S. markets for products containing mineral fillers that may be expected in a given area. For example, the population of the eight Mountain states in 1954 was 3.6 pct, and retail sales in these states were 3.8 pct of the U. S. total, but the value added by manufactures was only 1.3 pct of the U. S. total. On the other hand, the three Pacific Coast states, with 10.3 pct of the total population, had 12.0 pct of the retail sales and produced 9.6 pct of the value added by manufactures.

On an industry-by-industry basis the correlation between the three guideposts will not be as close as shown in the 1954 data for the Pacific Coast states, but in the long-term view the continuing rapid population growth in the western states is certain to result in expanded industrial production at an even more accelerated pace, which will shorten the gap between local consumption and production in most major groups of manufactured consumer goods. Of course, there will always remain favorable areas for production of specific products. Such special situations must be individually analyzed.

Fig. 1 compares the population trends in the U. S., the western states, and California with Real Gross National Product from 1910 to 1957, with forecasts to 1970.

It is estimated[2] that the U. S. Real Gross National Product, as measured by the value of goods and

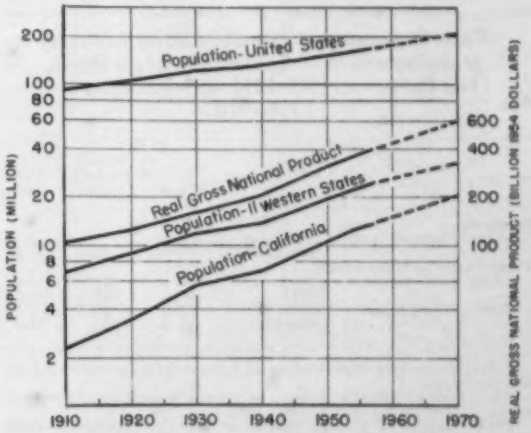


Fig. 1—Population of U. S., 11 western states, and California, and Real Gross National Product (1954 dollars), 1910-1957. Forecasts to 1970. (Dept. of Commerce.)

W. F. DIETRICH, Member AIME, is Chief, Division of Mineral Resources II, U. S. Bureau of Mines, San Francisco. TP 59H89. Manuscript, Feb. 16, 1959. San Francisco Meeting, February 1959. AIME Trans., Vol. 214, 1959.

Table I. Population, Retail Sales, and Value Added By Manufactures in U. S. and in Eleven Western States in 1954

States	Population		Retail Sales		Value Added by Manufactures	
	Thousands	Percent of U. S. Total	Billion Dollars	Percent of U. S. Total	Billion Dollars	Percent of U. S. Total
United States	161,200	100.0	170.0	100.0	116.9	100.0
11 Western States	22,400	13.9	26.8	15.8	12.7	10.9
Pacific Coast	16,683	10.3	20.4	12.0	11.2	9.6
California	12,254	7.6	15.6	9.2	8.6	7.4
Oregon	1,648	1.1	1.9	1.1	1.0	0.8
Washington	2,527	1.6	2.9	1.7	1.6	1.4
Mountain States	5,680	3.5	6.4	3.8	1.5	1.3
Arizona	930	0.6	1.0	0.6	0.20	0.17
Colorado	1,492	0.9	1.7	1.0	0.47	0.40
Idaho	598	0.4	0.67	0.39	0.18	0.15
Montana	619	0.4	0.78	0.46	0.14	0.12
Nevada	212	0.1	0.33	0.19	0.06	0.05
New Mexico	769	0.5	0.73	0.42	0.13	0.11
Utah	762	0.5	0.73	0.42	0.28	0.24
Wyoming	298	0.2	0.38	0.22	0.05	0.04

Source: U. S. Bureau of Census.

services produced, will increase at the rate of about 3.2 pct a year, compounded, over the period 1954-1970.

At this rate the Real Gross National Product would double every 22 years. Although this is slightly higher than the historic rate of the past 100 years, it is still the conservative view. Many economists predict more rapid growth. The annual growth of the value added by manufactures is assumed to be 3 pct, compounded during the 1954-1970 period. This is slightly less than the assumed growth of the Gross National Product which probably will reflect an increasing proportion of services.

On the basis of these assumptions and on U. S. Bureau of Census projections of population, the value added by manufactures in the U. S., the 11 western states, and California were calculated for 1970 (Table II). Overall requirements for mineral fillers in the U. S. should follow rather closely the *value-added* trend but, of course, the market trend for individual minerals will deviate more widely from the manufacturing growth owing to changes in technology and in the relative availability of specific materials and acceptable substitutes on a cost-quality basis. The overall regional trends in demand for mineral fillers also will tend to follow the pattern of industrial growth, again as influenced by technologic and cost factors. Individual commodities, however, probably will show some striking anomalies on a regional basis.

Table II. Population Trend and Value Added by Manufactures in U. S., Eleven Western States, and California, 1929-1954, with Forecasts for 1954-1970

		U. S.	Eleven Western States	California
Population				
Annual increase, pct	1929-1954*	1.14	2.64	3.25
	1954-1970**	1.54	2.67	3.21
Value Added by Manufacture				
Billion 1954 dollars	1954†	116.9	12.7	8.6
	1970‡	187.6	30.0	18.5
Annual increase, pct	1929-1954†	6.2	8.5	9.1
	1954-1970	3.0	5.5	4.9

* Calculated from U.S. Bureau of Census midyear estimates for 1929 and 1954.
** Calculated from U.S. Bureau of Census *Illustrative Projections of the Population by States, 1960, 1965, and 1970.*
† U.S. Bureau of Census, *Census of Manufactures, 1954.* (1929 data converted to 1954 dollars by use of GNP deflators.)
‡ Based on assumed national increase at 3.0 pct per year and calculated values for the western states and California, correlated with population projections and adjusted by the author for estimated per capita value added by manufactures in 1970.

CURRENT PRODUCTION AND CONSUMPTION OF SELECTED FILLERS

Table III shows the estimated percentage of total apparent supply of mineral fillers produced in the U. S., in the western states, and in the principal producing states.

Of the materials listed in Table III, production from the western states is adequate to supply the requirements in those states except for asbestos, barite, kaolin, mica, and ground silica. Consumer preferences provide a market for small quantities of eastern talc and pyrophyllite, yet California and Montana are important suppliers of talc to consumers outside the western states, especially for paper and paint uses. California, Nevada, and Oregon supply practically all of the diatomite used for all purposes in the U. S., and exports of processed diatomite to foreign countries are substantial. Asbestos is the only material listed in Table III in which U. S. production is far behind requirements—about 94 pct of the apparent U. S. consumption is imported, mostly from Canada. Barite imports, largely from Mexico and Canada, are currently at a high level, although in 1948-1952 imports averaged only 7 pct of U. S. consumption.

Table III. Distribution of U. S. Production of Selected Minerals Used as Fillers in 1957

	Estimated Percent of Total Apparent Supply		
	U. S.	Eleven Western States	Principal Producing States
Asbestos	6	1*	Vermont
Barite	61	15	Arkansas, Missouri, Georgia
Clays:			
Kaolin	97	3	Georgia, South Carolina
Fuller's earth	100	4	Florida, Georgia, Tennessee
Diatomite	100	100	California, Nevada, Oregon
Limestone and products	100	8	Ohio, Missouri, Pennsylvania
Mica (grinders scrap and flake)	92	5	North Carolina
Silica (ground sand)	100	1*	Illinois, West Virginia, New Jersey
Talc and soapstone	100	28	New York, California, Georgia
Pyrophyllite	100	10	North Carolina

Source: U.S. Bureau of Mines.
* Less than 1 pct.

The estimated quantity and value of the 1957 consumption as fillers of the selected minerals in the U. S. are shown in Table IV.

GROWTH TRENDS OF PRINCIPAL FILLER-CONSUMING INDUSTRIES

As shown in Table V, five industries consumed 88 pct of the value of the selected mineral fillers used in the U. S. in 1957: paper, rubber, asphalt, insecticide, and paint.

The pulp, paper, and paper-products industries of

the U. S. grew at the rate of 5 pct annually from 1929 to 1954, as measured by the value added by manufacture in constant dollars. This growth is somewhat more rapid than that of the Real Gross National Product. In 1954 production of the paper industries of the western states in proportion to the entire continental U. S. was comparable to other manufacturing industries in those states.

The 11 western states produced about 16 pct of the U. S. paper pulp in 1954 but only about 7 pct of the paper, paperboard, and building paper and board and 5 pct of the coated and glazed paper. On the other hand, nearly 8 pct of the paper and paperboard used in manufacturing paper products in the U. S. was consumed in the western states. Since total retail sales in the western states in 1954 were nearly 16 pct of the U. S. total retail sales, consumption of coated and glazed paper in the western states probably was at least 15 pct of the U. S. total, or three times production in the western states.

The value added by the manufacture of rubber products in the U. S. from 1929 to 1954 increased at about the same rate as the Real Gross National Product. The proportion of the entire industry located in the 11 western states in 1954 was 9.7 pct, compared with 10.9 pct of all manufacturing industries. However, there was then and even now virtually no white-rubber production in the western states; hence the market for white-rubber fillers in these states is negligible.

Data on the insecticide and fungicide-producing industries were not reported separately by the U. S. Bureau of Census before 1939. The growth rate of of the industry from 1939 to 1954, as measured by the value added by manufactures, was 15 pct annually, more than three times the growth of Gross National Product and about two and a half times the growth of the value added by all manufactures in the same period. In 1954 the 11 western states contributed 35.4 pct of the U. S. total of the value added by manufacture of insecticides and fungicides. In the same year sales for use in insecticides and fungicides of talc, soapstone, and pyrophyllite by producers in the western states were 32 pct of the U. S. total sales of these materials for the same uses.

The value added by manufacture of paint and allied products in the U. S. increased 3.0 pct annually from 1929 to 1954, the same as the increase in Real Gross National Product. Although as yet the 11 western states probably produce only about half as much of these products as is consumed in the area, California production, if all were used in the state, nearly balances consumption.

Table IV. Estimated Quantity and Value of Consumption as Fillers of Selected Minerals in U. S. in 1957

Commodity	Use	Quantity, Thousand Short Tons	Subtotals	Value, Thousand Dollars
Asbestos	Asphalt tile and other	175	175	7,000
Barite	Paint	16		
	Rubber	22		
Total			38	1,400
Clays:				
Kaolin	Paper Coating	650		
	Paper filling	528		
	Rubber	301		
	Insecticide and fungicide	30		
	Paint	35		
	Fertilizer, plastics, other	76		
Total			1,640	41,000
Fuller's earth	Mostly insecticide and fungicide	70	70	1,200
Other clays	Insecticide and fungicide	20		
	Linoleum and oilcloth	12		
	Other	11		
Total			43	800
Diatomite	Wide range of uses	101*	101*	3,800*
Limestone and Products:				
Limestone, crushed	Asphalt	2,054		
	Fertilizer	345		
	Other	541		
Total			2,940	8,200
Limestone whiting	Paint, rubber, caulking compound, other	809	809	6,000
Lime, quick	Insecticide, fungicide, disinfectant	15		
	Paint and other	15		
Total			30	700
Lime, hydrated	Insecticide, fungicide, disinfectant	48		
	Paint and other	26		
Total			74	1,400
Mica, Ground	Roofing	30		
	Paint	23		
	Joint cement	13		
	Rubber, wallpaper, plastics	12		
Total			78	5,000
Silica, Ground Sand	Rubber, plastics, other	134	134	1,200
Talc and Soapstone	Paint	120		
	Insecticide	45		
	Roofing	30		
	Rubber	29		
	Asphalt filler	19		
	Paper	16		
	Other	72		
Total			340	9,000
Pyrophyllite	Insecticide	42		
	Asphalt, paint, rubber, other	56		
Total			98	1,400
Grand total			6,527	87,300

Source: U.S. Bureau of Mines.
* 1954-1956 average.

SUPPLY-DEMAND STATUS OF SELECTED MINERAL FILLERS

Asbestos: Most of the asbestos of Canadian group 7 or equivalent consumed in the U. S. is used for boiler and roofing cements and as filler in asphalt floor tile and various other products. In 1957 the apparent supply of group 7 asbestos, mostly from Canada, was about 350,000 short tons, valued at about $15 million. It is estimated that 150,000 to 200,000 tons were consumed for filler uses. Small quantities of other grades of asbestos, especially group 8, also are used for fillers.

Less than 1 pct of the U. S. supply of asbestos is produced in the western states, and the chance of substantially improving the supply appears remote. Current (1958) consumption of asbestos fillers in the western states is believed to be about 4 pct of the national total, although consumption of products containing asbestos fillers probably is at least twice as great. Hence, while there appears to be room for expansion of the asbestos-filler consuming industries in the West, the asbestos supply will continue to be obtained largely from Canada and Vermont.

Barite

Only about 2 pct of the barite consumption in the U. S. is used as filler—mostly in rubber and paint. Although nearly 40 pct of the crude barite requirements of the U. S. is imported, about 15 pct of the total domestic supply is produced in the western states. However, only a small part of the western production is of filler grade.

Clays

Kaolin: Kaolin acounts for about one fourth the tonnage and half the value of the domestic mineral-filler consumption; three fourths of the domestic kaolin consumption is used as fillers. The three major filler uses are paper coating, paper filling, and rubber.

From 1947 to 1957 U. S. consumption of kaolin fillers increased at the rate of 4.5 pct annually, reflecting the growth of the consuming industries.

Most of the filler-grade kaolin used in the western states is obtained from Georgia and South Carolina. The freight on kaolin from Georgia to Los Angeles is $21.80 per ton; hence, Georgia paper clays sell at $33 to $40 per ton, f.o.b. Los Angeles. The freight from Georgia to the Pacific Northwest is about $26 per ton.

The high cost of kaolin fillers delivered to West Coast industrial areas has been a major factor in retarding the growth of the white paper and white food-carton industries in this area and probably has also had an adverse effect on establishment of plants for making various other products requiring high-grade fillers. The first major breakthrough in establishing a western supply of paper clays may be the beneficiation plant of the J. R. Simplot Co. at Bovill, Idaho, now (February 1959) under construction. On the basis of cooperative studies by the U. S. Bureau of Mines, it is believed that high-grade paper filling and coating clay can be produced from the Bovill clays. Although the dominant mineral in these clays is halloysite, little difficulty is anticipated in introducing the beneficiated clay in a wide range of products in the Pacific Northwest at somewhat lower cost than Georgia kaolin on a delivered basis.

Fuller's Earth: The principal use of fuller's earth as a filler is in insecticides and fungicides. Production in the western states is small, and most filler requirements are met by regionally available substitutes, especially pyrophyllite.

Other Clays: Small quantities of ball clay, fire clay, and miscellaneous clay are used as fillers in special applications where price and availability are favorable.

Diatomite

The use of diatomite fillers increased about 7 pct annually from 1949 to 1956, more rapidly than for any other major mineral filler. About 25 pct of the domestic diatomite consumption is used as a filler in paper, paint, varnish, and many other items. All of the domestic production is in California, Nevada, Oregon, and Washington. The diatomite filler market in the Pacific Coast states probably is somewhat higher in proportion to total industrial activity than elsewhere in the U. S.

Limestone and Products

Crushed Limestone: The western market for crushed limestone for use as a filler in asphalt, fertilizer, and other products is approximately proportionate to the level of manufacturing and construction activity, compared with the entire U. S. Adequate raw material supplies and production facilities serve the metropolitan areas in the West. Since crushed limestone used as a filler has low-unit value ($2 to $4 per ton, f.o.b. plant), there is little movement of crushed limestone far from the sources of production.

Limestone Whiting: Limestone whiting and precipitated calcium carbonate have almost entirely replaced imported chalk whiting, which dominated the market before World War I. Limestone whiting has a variety of filler uses, as in rubber, calcimine paint, caulking compound, putty, and asphalt. The western market is approximately in balance with supply from western sources, although higher prices widen the competitive marketing area compared with crushed limestone. Prices delivered in the Los Angeles metropolitan area range from $8.70 per ton for asphalt filler to $13.50 for 180 mesh putty-grade material, $16.50 for 400 mesh paint filler, and $35 for extremely fine-ground, low-micron paint fillers.

Lime: Both quicklime and hydrated lime have minor uses as fillers in insecticide, fungicide, disinfectant, paint, glue, medicines and drugs, rubber, and soap. The western supply-demand position is in balance.

Mica

About 80 pct of the ground mica sold by producers in the U. S. in 1957 was used as filler, principally in roofing, paint, joint cement, rubber, wallpaper, and plastics. From 1947 to 1957 the consumption of ground-mica fillers increased about 4 pct annually.

Table V. Estimated Value of Selected Mineral Fillers Used in U. S. in 1957, by Consuming Industries

Consuming Industry	Value, Million Dollars	Percent of Total
Paper	30.1	34.5
Rubber	15.7	18.0
Asphalt	15.7	18.0
Insecticide	7.9	9.0
Paint	7.5	8.6
Other	10.4	11.9
Total	87.3	100.0

Source: U.S. Bureau of Mines.

It is estimated that mica-filler consumption in the western states is at least double the current supply from those states. Shipments from mica-grinding plants in the Southeast to California alone are believed to exceed 3000 tons annually, valued at $200,000.

Silica

Silica, in the form of ground sand, is used extensively as a filler in rubber and plastics. Development of raw-material resources and plant facilities keeps pace with industrial demand in most geographic areas, but demand in most western states thus far greatly exceeds the local supply.

Talc and Soapstone

Consumption of talc, soapstone, and pyrophyllite fillers increased about 4 pct annually from 1947 to 1957. Separate data for pyrophyllite for this period are not available.

The western states produce about twice as much talc as is consumed by western industries. Even so, the proximity of California talc deposits to southern California industries, together with extensive technological and marketing research and the lack of western sources of kaolin fillers, has resulted in establishing a market for talc in California at somewhat higher than the proportionate level of manufacturing elsewhere in the U. S.

In 1957 filler uses accounted for 64 pct of the talc and soapstone production in the U. S. Chief among these were paints—second only to ceramics—insecticides, roofing, and rubber.

Prices of California filler talc and soapstone delivered in the Los Angeles area range from less than $20 to more than $70, depending on quality and particle size. The softness and high gloss of the best qualities of California talc give it a favored status as a paint and textile filler. Continued research on the properties and processing of western talcs, notably those from California, Nevada, and Montana, is expected to extend the range of consumer acceptance, especially in the paper and rubber industries.

Pyrophyllite

Over 60 pct of the U. S. pyrophyllite consumption in 1957 was used as filler, principally in insecticide, asphalt, paint, and rubber. For most filler uses, pyrophyllite and talc of equivalent particle size distribution and whiteness are interchangeable, and the choice depends primarily on price. Western pyrophyllite, however, is usually too dark in color to be acceptable as a white paint filler and is used mainly for insecticides. In the Los Angeles area insecticide-grade pyrophyllite sells for about $18 per ton, compared with about $25 per ton for insecticide-grade talc.

The supply of western pyrophyllite keeps pace with requirements in the western states. Interregional shipments are negligible.

REFERENCES

[1] A. B. Cummins: Mineral Fillers: In *Industrial Minerals and Rocks*, 2nd ed., pp. 870-878 (Table I). AIME, New York, 1949.
[2] U. S. Bureau of Mines: Office of the Chief Economist.

Discussion of this article sent (2 copies) to AIME before Sept. 30, 1959, will be published in MINING ENGINEERING.

AIRBORNE GRAVITY METER

DESCRIPTION AND PRELIMINARY RESULTS

by HANS T. LUNDBERG and JOHN H. RATCLIFFE

In airborne gravity surveys effects of acceleration and irregular movements of the aircraft must be balanced out or overcome. The gradient of vertical gravity is recorded, therefore, by using two masses instead of one. As the amplitude variations are infinitesimal and difficult to measure accurately, at present it is enough to determine whether variation of gradient during flight is positive or negative. The positive portions of the pattern can then be indicated and contoured. Even with these simplifications, the source of energy must be exceptionally stable.

General Principles: In the conventional gravimeter the weight of a standard mass is determined at a number of selected points within the survey area. In most systems weight is determined by comparing the gravity pull with extension or torque

H. T. LUNDBERG, Member AIME, is President and J. H. Ratcliffe, Chief Geophysicist, Lundberg Explorations Ltd., Toronto, Canada. TP 4815L. Manuscript, June 16, 1958. New York Meeting, February 1958.

produced in a wire spring. The instruments employed are sensitive to the slightest movement; they cannot be used on a moving platform unless velocity is kept strictly uniform.

Assume, however, that two similar masses are suspended from each end of a very short linking beam, one mass lower than the other. At center point the beam is suspended from a supporting platform by a frictionless pivot. A fixed plate close to the plane surface of one mass acts as a variable condenser. Displacement of the mass in respect to the fixed plate can be electronically determined.

When the beam is made to stay horizontal on neutral ground the vertical distance between the two masses equals the difference in length of the two supporting filaments. When the system is moved into a field of increasing gravity, the lower mass is attracted downward slightly more than the upper one. The lower mass will thus move downward and the upper mass upward until equilibrium is reached. This displacement can be observed by the change in capacity between the mass and the fixed plate.

If the balance system is suspended from a moving platform, forces due to acceleration in any direction will then be applied equally to each mass, provided the acceleration remains constant. If acceleration varies, as in an aircraft bump, differential forces may be applied to the mass, causing a short-term, small-amplitude *hash* to be superimposed on the output signal. However, as these changes in acceleration are generally of short duration compared with the gravity anomalies, this disturbance can be filtered out electrically.*

* Certain long-time changes caused by the aircraft flying an arc of large radius rather than a straight line may slightly displace the datum, but the local anomalies superimposed on it will still be in their correct position.

Theoretical Considerations: Consider the actual magnitude of the forces involved. For example, at a point 1000 ft vertically above the uppermost surface of a sphere of 2500-ft radius having a density contrast of 1 over its surroundings, a gravity anomaly of about 10 milligals, or 10^{-3} C.G.S. units, will result. The first vertical derivative of gravity at this point will then be about 2×10^{-7} C.G.S. units or 200 Eötvös units, while the second vertical derivative anomaly will be only about 6×10^{-10} C.G.S. units. Obviously it is preferable to work with either the vertical component or the first vertical derivative of gravity, as the higher derivative necessitates measuring such extremely minute quantities.

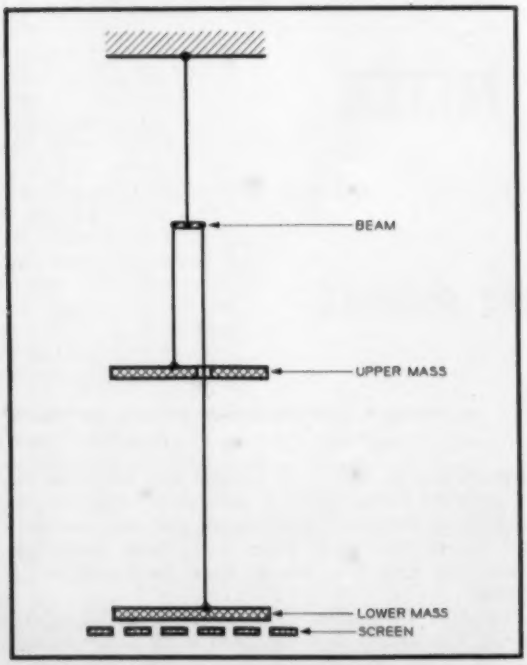


Fig. 1—Diagram of the moving system of the gravity gradiometer. Scale is highly distorted and enlarged.

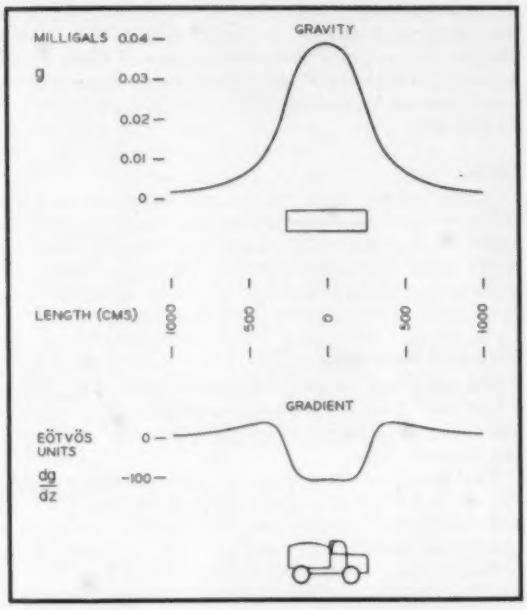


Fig. 2—Calculated gravity gradient anomaly over moving sand truck. This comparison is simplified in Fig. 3.

The conventional gravimeter measures variations in the gravity field of the order of 0.01 milligals or 10^{-5} C.G.S. units. Helmer Hedstrom (1938)[1] describes a gravimeter in which the mass displacement is determined by measuring variations in electric capacity. He states that in the Boliden gravity meter a 1-milligal anomaly would cause a deflection of the moving system of about 5.5×10^{-7} cm. As the instrument could register movements of the order of 3.5×10^{-8} cm, or 0.35 Angstrom units, it was theoretically possible to detect gravity anomalies of the order of 0.01 milligals. Although this sensitivity was never reached in the field, it is interesting to note that under controlled conditions a sensitivity of this order could be obtained with electronic devices that would now be considered obsolete.

It has been shown that anomalies in the first vertical derivative are much smaller in magnitude than those of the equivalent gravity. The question is, therefore, can the airborne instrument detect anomalies in the first vertical derivative? The equations of motion for the system have been developed, and it is found that the first vertical derivative of gravity is proportional to the displacement of either mass (the constant of proportionality being about 0.5). Thus a change of 1 Eötvös unit in the first vertical derivative will cause a mass displacement of 0.2 Å.

The 0.35 Å movement that can be detected by the

Boliden gravity meter corresponds to a sensitivity of 2 Eötvös units. Although this figure is theoretically plausible, it may be somewhat optimistic. By actual observations it is known, however, that the present instrument described here is capable of detecting a movement of 5 A, that is, a change of about 25 Eötvös units in the first vertical derivative of gravity.

To reach this sensitivity all components of the gravity gradiometer must function with perfect precision. Power packs, oscillators, and amplifiers must have linear characteristics over the operational range, and to hold temperature effects to a minimum, materials with low coefficients of expansion must be used. These and similar design problems have persistently dogged the writers' development program.

Instrumental Details: The complete instrument comprises an ultra-stable power supply feeding a timing device that in turn controls operation of the moving balance system in the head unit. Changes in relative position of the two masses within the head unit are relayed by a capacity bridge circuit, which feeds through an amplifier into a recording device.

In the early models the recording apparatus consisted merely of a set of head phones. By detecting changes in signal tone it was possible to map changes in the gravity field. It is obvious, however, that for survey work automatic data recording is essential. In their present models the writers are using a standard automatic recording milliammeter.

The timing mechanism regulating movements of the masses in the head unit requires a 60-cps power source not generally available in aircraft, so the instrument is operated from a d-c supply. The output of vibrator systems and rotary converters was found too unstable for linear operation of the timing device, but a crystal-controlled, frequency-divided, voltage-regulated power supply has proved eminently satisfactory.

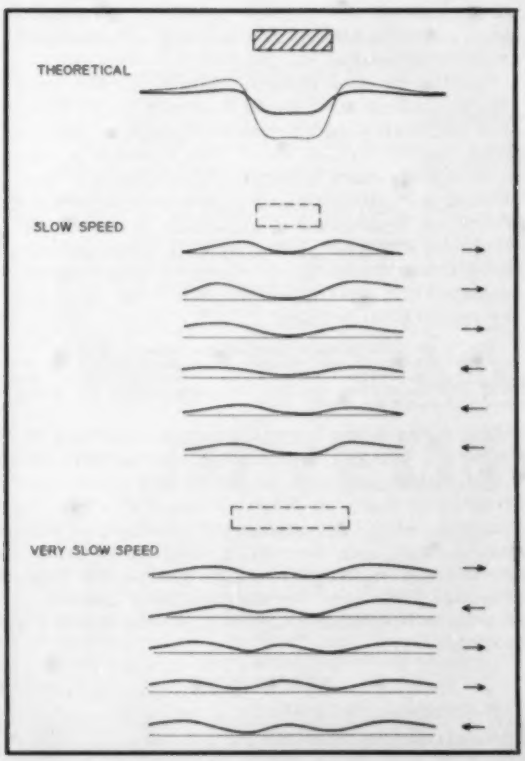


Fig. 3—Gravity gradient anomaly over moving sand truck.

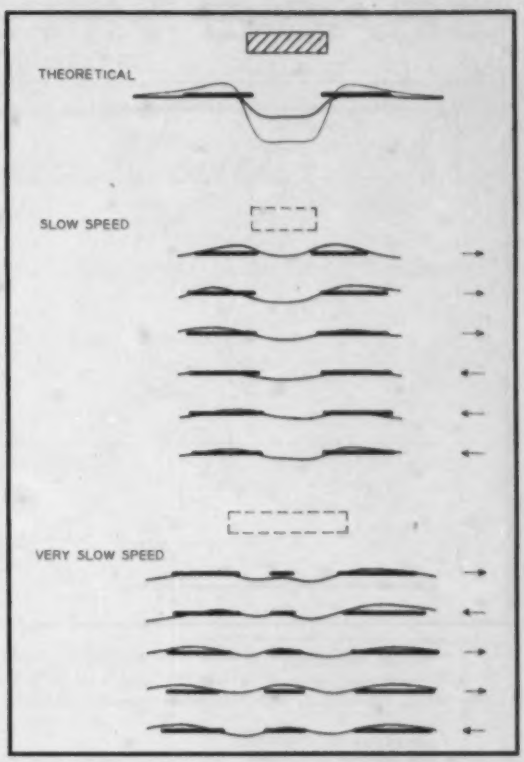


Fig. 4—Gravity gradient anomaly over the moving sand truck. The positive portion of the gradient is indicated.

The frequency-controlled timing unit locks the two masses in a central position in their housing while the distance between one of the masses and the fixed plate is measured by means of the capacity bridge. The masses are then freed and the cycle is repeated. Each cycle thus consists of two periods: 1) During the static period a strong electrostatic charge returns the masses laterally to a central position in their housing without disturbing their relative vertical position and then permits the capacity between one mass and the fixed condenser to be compared with a known capacity in the bridge circuit. 2) During the dynamic period the two masses are free to seek a new position of equilibrium under the influence of differential gravity forces acting upon them.

The cycling speed of the timing device can be altered by external controls. It is therefore possible to synchronize the dynamic period of the instrument with a fraction of the natural period of vibration of the mechanical system, so that the two masses, which have been under restraint during the static period, will tend to move toward a new equilibium point. If they were allowed to oscillate freely, they would continue about the new equilibrium point *ad infinitum* in the absence of damping, the amplitude of oscillation being a function of the original restraining force. But during this period accelerations applied to the moving platform might cause the masses to become misaligned. For this reason they must be locked periodically. The best time to

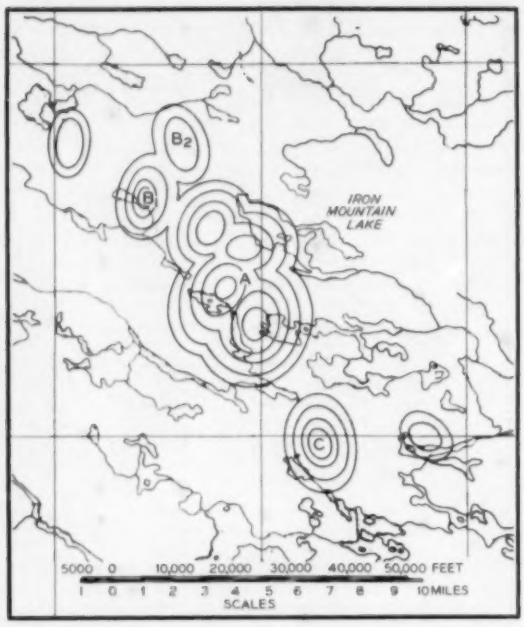


Fig. 5—Results of airborne gradiometer survey over the Iron Mountain lake area, New Quebec. Altitude 1000 ft. North-south east-west flight directions are combined.

impose the locking system, of course, is at a point equal to one quarter or three quarters of the natural frequency of the oscillating beam system.

Tests and Trials: In early tests of the instrument, carried out on the ground, traverses were made on foot over a narrow lead vein. Later the instrument was mounted in a station wagon and driven back and forth over a straight, flat stretch of highway which crossed a known gravity anomaly. When good results were finally obtained, the instrument was placed in an aircraft and flown over the same route. Naturally transposition from a ground to an airborne device created additional problems. Many of these are still being sorted out, but the goal is rapidly being attained.

An interesting test was recently made by running a heavy truck loaded with gravel under the instrument, which was mounted stationary above the roadway. Recordings of gravity gradient variations were made in the usual way. To obtain proper records the truck had to move at a speed too slow to be read on the speedometer. This caused the engine to heat up so that toward the end of the testing period it was difficult to drive the truck at even speed. Even so, the recorded runs showed very interesting results. By way of comparison, Fig. 2 shows the calculated gradient for a 15.8-ton block measuring 17x4x7 ft, corresponding approximately to the gravity effect of the truck loaded with gravel. In Fig. 3 the amplitude scale of the calculated variations has been considerably reduced, for easier comparison with the recorded profiles.

For the moderately slow runs the recorded profiles look very similar to the calculated curve but, as might be expected, for very slow runs the character of the profiles changes, showing a pronounced bump over the gravel truck owing to the change in scale factor.

Interpretation: It is still an art to interpret the data. As the system is very sensitive to the relation between the timing cycle and the natural frequency of the moving beam, exact synchronization of the two cannot be accomplished with the present equipment, so that no true values are recorded, but only the changes in vertical gradient of gravity. It is possible, however, to indicate where the gravity gradient is positive and where it is negative.

To prepare data for interpretation the record tapes are transcribed into constant scale and corrected for curvilinear coordinates. The transcribed records are traced onto flight line maps in profile form. The positions of positive gravity gradient zones are marked off on the profiles (see Fig. 4) and the zones are then joined, by contouring, into a series of concentric rings which surround the mass causing the anomalous gravity field (see Fig. 5).

At first lines were flown in two directions perpendicular to each other at two different altitudes. After four maps had been produced and contoured independently, the results were matched. Where anomaly centers coincided, existence of a gravity anomaly could be postulated. Although this conservative approach has been costly, it has built up a safe interpretation technique that is in the best interest of the client.

Future Development: The airborne gravity gradiometer is still in its infancy. Three types of power supply have been tried, different moving beam systems have been incorporated into the head unit, various amplifiers have been designed and tested, and two systems of data recording have been used. The writers consider the present unit vastly superior to its predecessors, but there is still much room for improvement. The authors hope to have, in the near future, an instrument that can record the true value of the gravity gradient, permitting a more accurate contour pattern and a mathematical analysis of results.

Conclusions and Present Results: In an earlier article[2] the authors showed examples of surveys over salt domes and bodies of magnetite. Although these results should speak for themselves, many professionals have inferred that they are useless because no exact value of a definite function is included in a discussion. Certainly an exact value would be desirable, but the writers are convinced that contour mapping of a function which indicates an anomalous gravity center should be of value in any exploration program.*

* Flat to moderate topographic relief has little or no effect on the recordings because of the relatively high flight altitude (1000 to 2000 ft). In more rugged terrain actual comparisons between topography and the gravity gradient anomalies provide an empirical method of rating the gravity results.

The method has been applied in many parts of the world and the originators have to their credit the discovery of a large, relatively nonmagnetic hematite orebody in West Africa. Salt domes and structures have been successfully outlined in Europe and Canada, and recently a very large iron ore deposit was outlined by this method in Canada (Fig. 5). Tests over bodies of sulfides and manganese have been made, but final results are not yet available.

REFERENCES

[1] H. Hedstrom: *AIME TP 953*, 1938.
[2] H. Lundberg: *Transactions*, Canadian Institute of Mining and Metallurgy, 1957, vol. 60, pp. 251-259.

Discussion of this article sent (2 copies) to AIME before Sept. 30, 1959, will be published in MINING ENGINEERING.

SME BULLETIN BOARD

Reports of Your Technical Society

PREPRINTS

The following preprints of interest to mining men in M&E are available from Society headquarters: Complete ordering data are given on page 102 in the Directory Section of the July issue:

A—Mining

59A91—Economic History of the Lake Superior Iron District by R. S. Archibald.
59A94—Industrial Relations at Kennecott Copper by Edmund Flynn.
59A109—The Seismic Wave from Plaster and Drill-Hole Explosive Charges by A. W. Ruff.

AO—Underground Mining

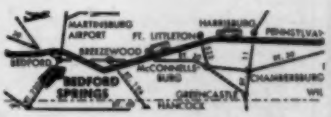
59AO29—Firing Fertilizer for Fragmentation by John R. Knudson.
59AO36—Selection of an Open Pit Haulage Method by W. N. Matheson.
59AO49—Expansion and Development of Transportation System in Chuquicamata by Robert Laurich.
59AO55—Improvements in Loading and Hauling Equipment and Their Effect on Unit Costs by Charles S. Davis.
59AO79—Drilling Methods and Equipment at New Cornelia Open Pit Mine by John E. O'Neill.
59AO83—Blasting with Commercial Grade Ammonium Nitrate at Utah Copper Pit of the Kennecott Copper Corp. by L. E. Snow.
59AO98—Replacement of Capital Equipment by H. J. Schweilenbach.
59AO102—Ammonium Nitrate Blasting Agents by Louis W. Towle.

AU—Underground Mining

59AU57—Ground Movement and Subsidence from Block Caving at Miami Mine by J. B. Fletcher.
59AU64—Mining at Gaspe Copper by W. G. Briddenden.
59AU71—Algom Nordic-Development to Production by E. R. Olson and Murray W. Airth.
59AU72—Safety Organization at Braden Copper Co. by Stanley Jarrett.
59AU75—Long Hole Drilling as an Aid to Mining and Development Work at United Park City Mines Co. by G. W. DeLaMare.
59AU83—Underground Storage for Hydrocarbon Fluids by Robert L. Loofbourow.
59AU84—A Campaign for the Elimination of Accidents at the Lavender Pit by W. K. Pincook.
59AU96—Mining Problems and Developments at Ambrosia Lake, New Mexico by D. T. Delicate.
59AU100—Pillar Recovery at the Mi Vida Mine by Virgil A. Bilyou and Theodore J. Barrett.

Starring - - - The AIME in the Pacific Northwest

Map stars locate sites of the annual Pacific Northwest Regional Meeting of AIME. 1959 is reviewed on page 825 and on the same page are given advance data on 1960.



Most up-to-date information on the joint Coal IndMD meeting to be held in September (24 to 26) at Bedford Springs, Pa., is given on page 822. Included is a revised program for the Friday joint Coal-IndMD sessions and corrected hotel rate data.

Proposals for Membership

Change of Address
Personals Data
Boxes
page 834

Mineral Information Section Begins on page 762

AIME Section Activities

Pennsylvania-Anthracite, page 828
Uranium, page 832
Around the Sections, page 830

NEWSLETTERS . . .

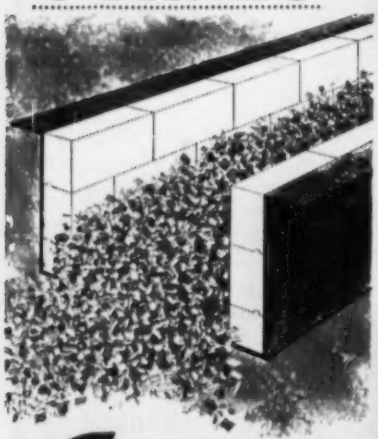
- Coal page 829
- MBD'ers Digest page 831
- Rock in the Box page 827

DIRECTORY

SME's 1959 Membership Directory was published in the July issue of MINING ENGINEERING. Separate copies are still available from the AIME Order Department (29 W. 39th St., New York 18, N. Y.) and cost $1. AIME is also offering for sale a handsome binder at $2.50 in which to keep the SME Directory. Directories of the Society of Petroleum Engineers and The Metallurgical Society are also available at $1 each. The entire package, including the three Society Directories and binder, cost $5. AIME members will be billed; nonmembers should include remittance with orders.

In Chute Linings...

OUTWEARS HARDENED STEEL 6 TIMES



ARLCITE® WEAR BLOCKS

Field tests prove the amazing wear resistance of ARLCITE Blocks in chuting the most abrasive ores and materials—up to six times the useful life of hardened alloy steels!

Tough-bond high-density ARLCITE is a super-ceramic block with hardness next to diamond. The exclusive tongue and groove design insures a tightly-keyed lining, is easily laid-up in the chute and resists wear evenly due to the uniform hardness throughout the block.

Investigate the money savings ARLCITE can bring in *your* material handling. Write us!

PORCELAIN DIVISION
FERRO CORPORATION
East Liverpool, Ohio

On May 28 representatives of the United Engineering Trustees and the Turner Construction Co. signed the contract for the erection of the United Engineering Center. Ground-breaking is scheduled for the fall, with occupancy planned for 1961. Seated from left to right at the Engineers Club in New York are Willis S. Thompson, chairman of the real estate committee for UET; Andrew Fletcher, president of UET; and E. K. Abberley, vice president of Turner Construction Co. Standing are Harold C. Bernhard, Shreve, Lamb & Harmon Assoc., architects; and W. B. Ball, Turner vice president.

N. Arbiter Appointed

The appointment of Nathaniel Arbiter to the post of chairman of the SME Nominating Committee for 1959-1960 has been unanimously approved.

Other members of the Nominating Committee are: ex-officio J. W. Woomer and S. D. Michaelson; *M&E*—John Payne, Jr., Rodgers Peale (alternate), Allen B. Bowman, Gloyd M. Wiles (alternate), Vincent Perry, Herbert Z. Stuart (alternate), Arthur A. Brant, Robert J. Searls (alternate); *Coal*—James C. Gray, G. R. Spindler (alternate), and David R. Mitchell, D. L. McElroy (alternate); *IndMD*—R. M. Grogan, D. R. Irving (alternate), and H. A. Meyerhoff, G. W. Josephson (alternate); *MBD*—H. Rush Spedden, Stephen E. Erickson (alternate), and N. Arbiter, Neil Plummer (alternate).

Program Revisions

Further changes in the program for the Coal-IndMD Bedford Springs meeting have been reported by Leon Dupuy, program chairman for IndMD. The meeting is scheduled for September 24 to 26 at Bedford Springs, Pa. The revised program for Friday, September 25, includes additions not received in time for the July issue.

Friday AM

Joint Session—Coal and IndMD

H. E. Mauck and Henry Hebley, Co-Chairmen

Acid Mine Drainage: *S. A. Braley.*

The Influence of Bacteria on the Formation of Acid Mine Drainage: *William Leathen.*

The Success and Weakness of Pennsylvania Regulations on the Formation and Control of Acid Mine Drainage: *L. E. Morgan.*

A Case History of a Difficult Mine Drainage Problem: *Ernst P. Hall.*

Joint Session—Coal and IndMD

Henry Hebley and Leon W. Dupuy, Co-Chairmen

Field Trip Preview: *Carlyle Gray* and *Arthur R. Socolow.*

Disposal of Sulphur Mine Effluents—How Freeport Solved Its Effluent Problems: *Paul D. Bybee and Frederick G. Deiler.*

General Discussion of Effluents: *Henry Hebley,* Discussion Leader; Panel: E. P. Hall, R. Trace, J. Rosance, J. J. Reilly, W. F. Mullen,

(Continued on page 824)

BOARD HONORS RETIRING INSTITUTE EMPLOYEES

Both well known to Institute members—Jim Ryan, above shown receiving a gold watch from AIME President Howard Pyle and Winifred Gifford, right, were honored on their retirement at the recent AIME Board of Directors meeting.

THE June 23rd meeting of the AIME Board of Directors marked the culmination of nearly 70 years of combined service to the Institute for three retiring members of the staff.

Mrs. Grace Pugsley Stickle, Mrs. Winifred Demarest Gifford, and Mr. James Ryan received the thanks and a "well done" from both the members of the Board and the staff at large.

The prize for longevity goes to Mrs. Stickle, who served the AIME nearly 40 years—longer than any former staff member. From the day she first walked into the Institute in October 1919, she spent the entire time in the Publications Dept. There she was responsible for many of the advertising functions—serving under no less than 12 advertising managers. "She has withstood the strain of changing immediate superiors and publications, both of which are somewhat inherent to the advertising department of a rapidly growing and diversified organization," read the Board of Directors citation.

Following a resolution of commendation, the Board presented Mrs. Stickle with a sterling silver vase, emblazoned with the AIME crest and words of appreciation.

Winifred D. Gifford, formerly secretary to AIME secretary, Ernest Kirkendall, put aside her pencil at this Board Meeting to accept the

members token of gratitude. As it is written in the minutes: "RESOLVED, that the Board of Directors commends Winifred Demarest Gifford for her faithful service to the Institute from 1947 to 1959. The Board of Directors appreciates her unusual qualifications combining editorial proficiency with secretarial ability of high degree. The Board notes, further, her tremendous capacity for work, while practicing diplomacy and good judgment at all times."

With this, the Board presented her with a portable television set.

Above, Grace Pugsley Stickle, after 40 years of service in AIME Publications Department, was presented a silver vase by the AIME Board on the occasion of her retirement.

James Ryan—"Jim" to those acquainted with the face familiar to the AIME convention circuit—is the third member of the retiring triumvirate. Chief Shipping Clerk at the Institute since 1943, he is perhaps better known to members as Assistant Convention Manager. Noting his contributions to convention arrangements, the Board's resolution reads: "RESOLVED, that the Board of Directors commends James Ryan for his faithful service from 1943 to 1959. The Board of Directors appreciates particularly his performance at meetings, his ability to make friends for the Institute, as well as for himself, and his goodhearted willingness to help anyone with a problem."

With these words the Board presented him with a gold watch.

William F. Ryan Will Receive NSPE Award

An award for outstanding service to the engineering profession was presented to William F. Ryan at the Silver Anniversary meeting of the National Soc. of Professional Engineers in New York, June 17 to 20. This 1959 NSPE Award was presented at the annual banquet, June 20, at the Hotel Commodore. Mr. Ryan is a former vice president of Stone & Webster Engineering Corp. His contributions in the field of mechanical design and his unselfish devotion to professional principles and ideals have earned this esteemed award.

For Years . . . and Years . . . and Years

. . . Highly Efficient Concentration

The SuperDuty® DIAGONAL-DECK® table is noted not only for the low cost of producing high grade concentrates, but for its ability to work at this same high level of efficiency for years on end . . . and with scarcely a glance from the operator. One man can supervise an entire battery of these tables . . . "as many as he can see." Send for Bulletin 118-C.

THE DEISTER CONCENTRATOR CO., INC.

The Original Deister Co., Established 1906

923 Glasgow Ave. Fort Wayne 3, Indiana

7473-287

JOY quick opening
SHEAVE BLOCKS

forged construction

The hook and side plates of the 6″, 8″ and 10″ sizes are *forged alloy steel.* The wheel is chrome-nickel-moly cast steel. All parts are heat-treated for strength and wear resistance.

simple & rugged

There are no pins, chains, bolts or nuts to handle or remove. TO OPEN JUST TURN AND PUSH . . . no parts leave the block to become lost. The rugged opening mechanism will last for the life of the block.

Write for Bulletin 287-7

JOY

Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.

In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario

New ESPS Officers for San Francisco Named

Engineering Societies Personnel Service (ESPS)—San Francisco Advisory Committee—elects officers at meeting attended by president, E. O. Kirkendall, and director of the Service, H. N. Appleton, during the AIME Annual Meeting in San Francisco. Left to right, seated, are: L. Art Norman, Equipment Engineers Inc., who has resigned; Ernest O. Kirkendall, Executive Secretary of AIME; Ben L. Raffin, Rothschild, Raffin & Weirick; H. Newell Appleton, assistant secretary, AIME: Richard M. Stewart, California Div. of Mines. Left to right, standing: Joe R. Decker, Western representative; Charles K. Lewis, Power Div., Bechtel Corp.; Eric Salo, Pacific Gas & Electric Co.; Martin W. McLaren, Electrical Div., Bechtel Corp.; Harvey N. Skow, Westinghouse Electric Corp.; A. B. Sabin, consultant; N. D. Cook, manager. Not present: L. L. Wise, Engineering News-Record; M. Weitzner, Bethlehem Pacific Coast Steel Corp.

The Engineering Societies Personnel Service, San Francisco Advisory Committee, named 1959 officers from representatives appointed by local sections of Civil, Mechanical, Electrical, Mining, Marine national engineering societies and the Engineers Club. National president, Ernest O. Kirkendall, and national director, H. Newell Appleton, attended the regular meeting.

The new officers are: Morris Weitzner, chairman; Ben L. Raffin, vice chairman; Eric Salo, secretary; Richard M. Stewart, treasurer; Martin W. McLaren, assistant secretary; Charles K. Lewis, assistant treasurer; Newton D. Cook, recorder; and Joe R. Decker, western representative.

Three Certificates of Valued Service were awarded to members of the San Francisco Advisory Committee for counsel and guidance to western engineers over their years of service. Larry L. Wise, retiring chairman, served for eight years. L. Art Norman, retiring secretary, had served for three years; and Harvey N. Skow, retiring assistant secretary, had been on the Committee for two years. The deep appreciation of the ESPS board of directors was expressed in the certificates awarded to these officers.

Program Changes

(Continued from 822)

R. L. Llewellyn, R. A. Teichman, Jr., L. E. Lynd, E. F. Koppe, K. C. Lindstrom, D. L. Monroe, O. M. Wicken, R. W. Hunt, J. D. Ward, P. D. Bybee, J. J. Shideler.

On Thursday H. O. Zimmerman will replace R. E. Salvati. Bedford Springs Hotel rates are $18 for a single and $15 per person for a double room.

Action Taken by AAAS

At its December 1957 meeting, the Council of the American Assn. for the Advancement of Science made a resolution approving in principle the general adoption of the metric system of weights and measures and appointed a committee to make a study of the most economical and feasible method of changing over to metric usage. The Council agreed to cooperate with the British Assn. in efforts to further this objective.

At its December 1958 meeting a progress report was presented, and in September 1959 the British Assn. will present its report. Section M-Engineering held a four-session meeting on National and International Aspects of Systems of Units during the meeting. The proceedings will be published as a Symposium volume. A second series of sessions on this subject is planned for the December 1959 meeting in Chicago.

AIME

BOARD OF DIRECTORS

Recent actions taken by the Institute Board of Directors.

► On the recommendation of the Nuclear Metallurgy Committee of the Inst. of Metals Division of The Metallurgical Society, D. W. Lillie has been appointed representative on the American Standards Assn. N2.4 Glossary Subcommittee.

► J. S. Vanick has been appointed Contact AIME Director to coordinate the rules of the three Societies' Admissions Committees for a term to expire February 1960. This appointment is in accordance with Art. V, Section 4(a) of the AIME Bylaws.

► Donald O. Kennedy was reappointed AIME representative at the annual meeting of the Joseph A. Holmes Safety Assn. which was held in Washington on Apr. 21, 1959.

► 1959 JOURNAL OF METALS Award was presented at the 42nd Annual Blast Furnace, Coke Oven, and Raw Materials Conference in St. Louis, April 1959. The winners were Y. Doi and K. Kasai, Sumitomo Metal Industries, Kokura Steel Works, Japan, for their paper *Making of Self-Fluxing Sinter and the Blast Furnace Practice with its 100 pct Sinter Burden.*

Pacific Northwest 1960 Conference in Portland

With this year's conference a part of the past, work has already begun for the future Pacific Northwest Regional Conference. The 1960 meeting will be held at Portland, Ore., in the newest hotel, the Sheraton, on April 28 through 30.

In charge of preliminary arrangements is Hollis M. Dole, general chairman. Ralph S. Mason, publicity chairman, is assisting him. The AIME Oregon Section will be host.

The original Northwest Industrial Minerals Conference began in Portland, spread to Spokane and Seattle, and gradually became a full-fledged regional convention. Now British Columbia also gives able support to the annual meeting.

Tentative program topics for the technical sessions include a gold experts' panel, refractories-aluminum industry, plus the basics: geology, extractive metallurgy, and mining, iron and steel.

The Pacific Northwest Convened in Seattle

Seattle was the site of the 1959 Pacific Northwest Regional Conference held April 16 through 18 at the Olympic Hotel. Special events included luncheons in the Georgian Room, the banquet in the Spanish Ballroom, and field trips to Bethlehem Pacific Coast Steel Corp. and the new electric furnace installation of the Boeing Renton Plant.

Technical sessions began on Thursday morning in the Rex Room, where geology was the keynote. Marshall T. Huntting acted as chairman, introducing the initial speaker, Howard D. Grover, who discussed coal resource investigations in the state. C. N. Savage then spoke on the black sands of central Idaho; Howard C. Brooks discussed mercury in Oregon; and H. M. Harris closed the first session with the paper: *Shales for Expanded Aggregate in the North Pacific Coast Area.*

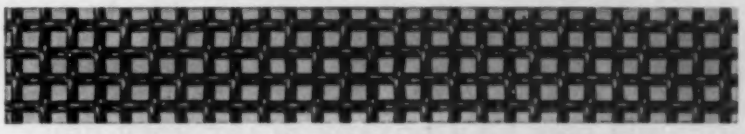
The Thursday luncheon featured speaker DeWayne Kraeger who lectured on the economic factors that affect the growth of the Pacific Northwest. Mr. Kraeger is director of Commerce and Economic Development for the State of Washington.

In the afternoon the minerals benefication session convened in the Colonial Room with Frederick B. Brien as chairman. Willard C. Aitkenhead opened the discussions with a paper entitled: *The Flotation of Oxidized Zinc Ores From Washington.* L. F. Wright discussed the concentration of magnetite ore at Empire Development Co. Inc., and G. V. Sullivan talked about chromite beneficiation. A. E. J. Gallagher considered some of the problems in the beneficiation of Pacific Northwest Pb-Zn ores, and the session was closed by two students from the University of Washington who presented their research projects.

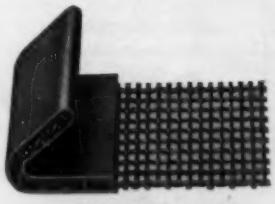
At the same time were sessions on petroleum in the Rex Room, and iron and steel in the Queen's Room.

On Friday morning simultaneous sessions covered extractive metallurgy, physical metallurgy, and mining. In the Colonial Room chairman Alvin F. Knoll introduced speakers on extractive metallurgy. Douglas Baker discussed the leaching practice at The Bunker Hill Electrolytic Zinc Plant. M. Gordon

(Continued on page 831)



TYLER SCREENS LAST LONGER

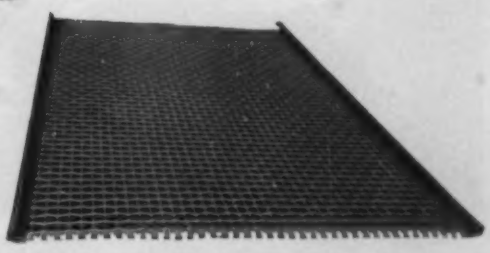


Tyler Type "AX" Hook Strip. For wire diameters from .047" to 5/16" inclusive.

Tyler Type "CX" Hook Strip. For wire diameters .041" and smaller.

Tyler Woven Wire Screens are woven with laboratory approved wires on precision machines. The high quality of Tyler Screens is apparent in their long life and service under the most difficult of screening conditions.

Tyler Screen Sections are furnished for all makes of vibrating screens in all meshes and metals. Each section is fabricated with the right type of edge or hook strip for the specification of screen cloth and to fit the particular make and model of screening machine on which it will be used.

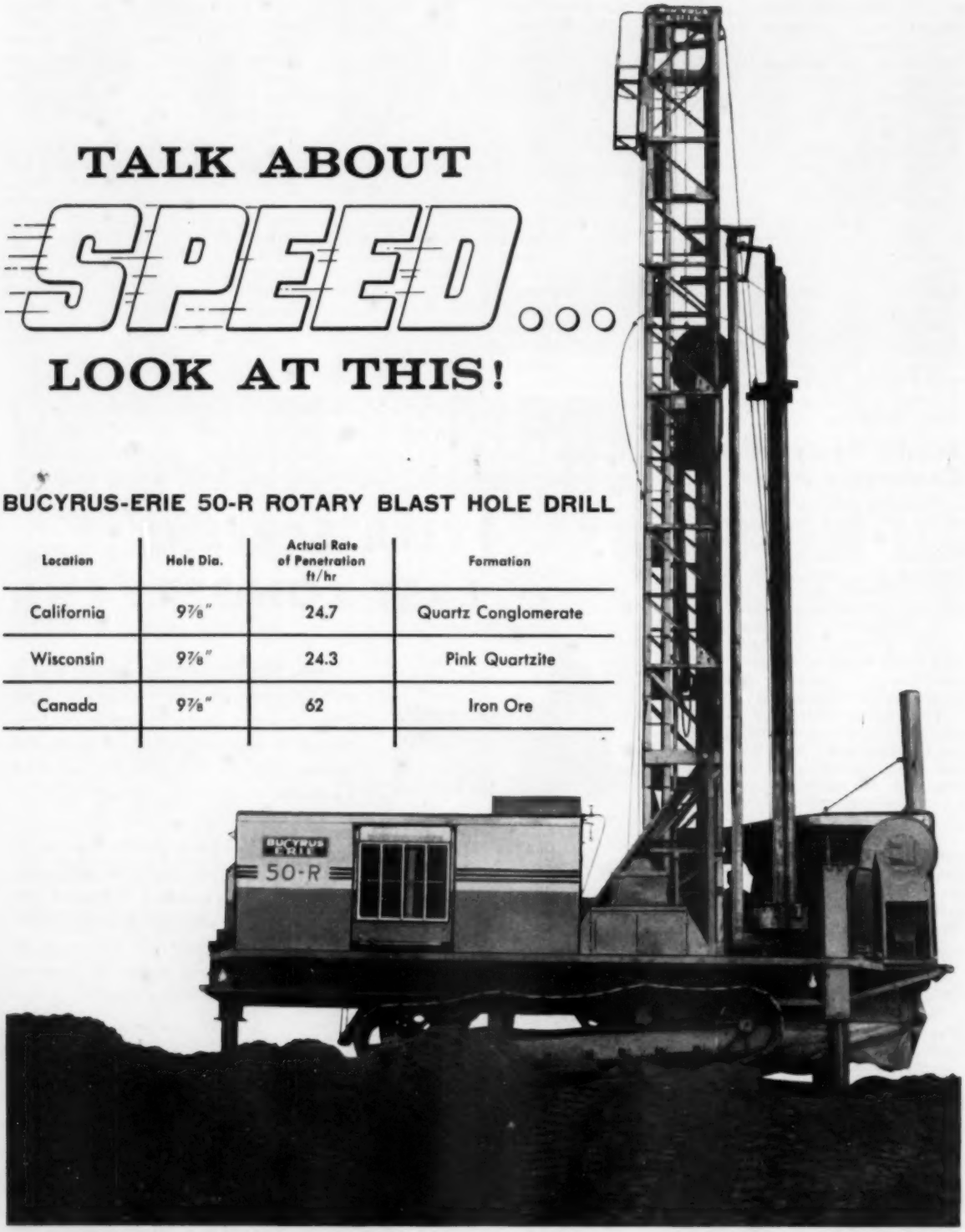


Telephone HE 1-5400 • *Teletype* CV 586

THE W. S. TYLER COMPANY
CLEVELAND 14, OHIO
Manufacturers of Woven Wire Screens and Screening Machinery

TALK ABOUT SPEED...

LOOK AT THIS!



BUCYRUS-ERIE 50-R ROTARY BLAST HOLE DRILL

Location	Hole Dia.	Actual Rate of Penetration ft/hr	Formation
California	9⅞"	24.7	Quartz Conglomerate
Wisconsin	9⅞"	24.3	Pink Quartzite
Canada	9⅞"	62	Iron Ore

These are typical production figures reported to us by owners of 50-R blast hole drills. We think they speak for themselves. No wonder it's the most wanted blast hole drill in the business.

Write for complete details. Bucyrus-Erie Company, Drill Division, Richmond, Indiana, Dept. 12BB.

BUCYRUS ERIE®

BUILDS BETTER EQUIPMENT

ROCK IN THE BOX

Mining & Exploration Division

Thanks to reports from AIME members in key planning positions for conferences of interest to M&E'ers, we are able to publish data on meetings not sponsored by AIME. The Drilling Symposium and SEG annual meeting are both valuable conferences open to members of the mining industry. S. H. Ward, chairman of the Geophysics Unit, is on the inside of SEG plans in his position as chairman of the mining technical program. Here is the available information on both these conferences.

Ninth Annual Drilling Symposium: Exploration and Development Drilling

The Ninth Annual Drilling Symposium will be held at the Pennsylvania State University from October 8 to 10 at University Park, Pa.

Exploration drilling will be the theme of the three-day sysposium which is sponsored by the departments of mining engineering at the University of Minnesota, Colorado School of Mines, and Penn State.

There will be five technical sessions on the following topics: statistics and operations in exploration; drilling unconsolidated materials; improving core recovery; drilling large-diameter holes; developments in bit design; down-the-hole drilling; and drilling to Moho.

Special events will include a buffet supper and social evening at the Centre Hills Country Club. On October 9 a banquet will be held at the Nittany Lion Inn.

The symposium is one of three jointly sponsored by the schools. Colorado was host for the Rocks Mechanics Symposium in April and will hold the Drilling and Blasting Symposium in 1960.

For reservations or additional information concerning the conference, write to: General Extension Conference Center, The Pennsylvania State University, University Park, Pa.

Program

Improving Core Recovery

Wire Line Core Barrel in Rhodesian Copper Deposits: *D. C. Squirrell*, Squirrell & Popplewell Ltd.

Writing Specifications and Contracts to Ensure Good Core Recovery: *J. S. Steel*, Quebec Cartier Mining Co.

Core Recovery in Diamond Drilling of Western Coppers: *Annan Cook*, Bear Creek Mining Co.

Summary: Recent Experimental Rotary Core Drilling on the Mesabi Range: *Ian Reid*, Oliver Iron Mining Div. *Thomas E. Stephenson*, Jones & Laughlin Steel Corp. *Richard Randolph*, Cleveland-Cliffs Iron Co.

Statistics and Operations Research

Determining an Optimum Prospecting Plan: *Robert J. Uffen*, University of Western Ontario

Probability as Applied to Mineral Sampling: *Scott B. Hazen*, U. S. Bureau of Mines

Statistical Applications in Exploration: *Philip Hermann*, Jones & Laughlin Steel Corp.

Theories of Search Distribution of Effort as Applied to Exploration: *Arthur A. Brown*, Arthur D. Little Inc.

Paper on mineral exploration in the Sahara.

Large-Hole Drilling

Controlled Drilling of Large Holes in Confined Spaces: *Thomas R. Trent*, Boring Inc.

Paper on large-hole boring with shaft and tunnel machines.

Paper on reaming holes in anthracite mining.

Paper on large-hole drilling in nuclear experiments.

New Practices in Drilling

Deep Hole Exploration Drilling at Marcona, Peru: *John J. Hayes*, Marcona Mining Co.

Use of Detergents in Air Drilling: *William C. Goins, Jr.*, Gulf Research & Development Co. and *H. J. Magner*, Delta Drilling Co.

Slim-Hole Drilling for Exploration: *Philip L. McLaughlin*, McLaughlin Co.

Design of Diamond Drill Bits: *E. M. Jenkins*, Christensen Diamond Products

Powder Metal Throw-Away Inserts for Rock Bits: *Horace Frommelt*, Spring Garden Inst.

Electromagnetic Bore-Hole Surveying: *E. Roxstrom*, Craelius Swedish Diamond Drilling Co.

Use of Chemical Grout for Soil Consolidation: *Leonard Mark*, Sprague & Henwood Inc.

SEG Annual Meeting Plans Are Underway

The Society of Exploration Geophysicists will hold its 29th annual meeting at the Hotel Biltmore in Los Angeles from Nov. 9 to 12, 1959. S. H. Ward, chairman of the mining technical program for SEG, and chairman of the Geophysics Unit, M & E Div. of SME, has announced a tentative program of technical sessions.

Papers of interest to the mining industry will be presented at four sessions beginning on Wednesday, November 11. At 9 am there will be a session on radiometric methods. Three or four papers are planned, including assaying by radioactivity, ore control by radioactivity, and drill-hole logging.

The Mining Luncheon will take place on Wednesday noon with L. B. Slichter, director of the Institute of Geophysics of the University of California, as guest speaker.

Wednesday afternoon the session will cover electrical methods. Papers on electromagnetic and induced polarization methods are already scheduled.

On Thursday the morning session will present mining case histories. Five very different exploration case histories have been arranged to emphasize the theme of the meeting: Integrated Exploration.

A symposium on magnetic and electric field variations will begin Thursday at 2 pm with four or five papers to be presented.

Robert Bowman has been in charge of arrangements for the radiometric methods and the electrical methods sessions. S. H. Ward has planned the case histories session, and George D. Garland is arranging the symposium. General assistance from John S. Sumner under the chairmanship of T. H. Braun, technical program chairman, has forwarded the plans for the meeting.

EDITOR

Address news items to:

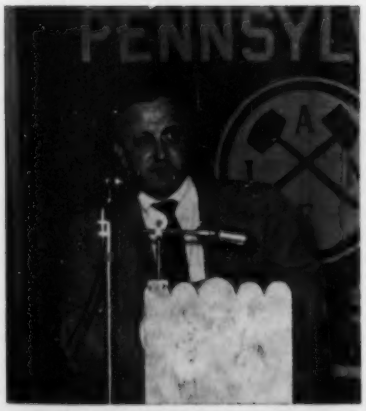
John W. Chandler, American Metal Climax Inc., 61 Broadway, New York 6, N. Y.

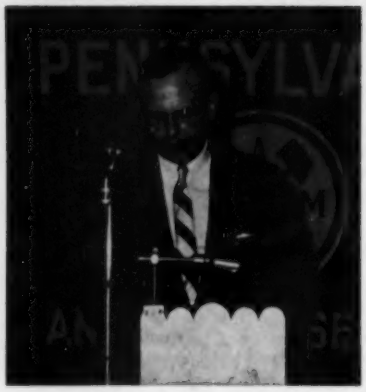
Penn-Anthracite Section Holds Special Meetings

On April 10 the spring meeting of the Pennsylvania-Anthracite Section was held at Genetti's in Hazleton, Pa. The well attended conference provided an interesting technical program arranged by John S. Marshall.

Charles Rubert presented a paper on hydraulic cutting and hydraulic transportation of gilsonite in underground mining, and Walter Haentjens gave a paper entitled *Slurry Pumping*. An operating display of slurry pumping with transparent pipes was set up and operated at one end of the meeting room, adding considerable interest to the session.

After the technical papers there were questions and discussion from the floor. Floyd S. Sanders, secretary of the Section, emphasized the importance of this free flow of ideas and information in a successful conference.





Summer Dinner

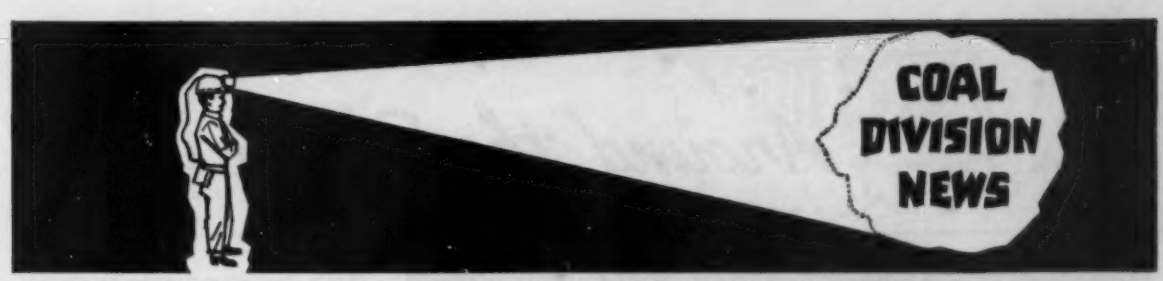
The annual summer meeting of the Pennsylvania-Anthracite Section featured a dinner at the Irem Temple Country Club, Dallas, Pa. on June 24. Howard C. Pyle, AIME President, was the principal speaker of the evening.

Golf and cocktails also were part of the program, with prizes for the best scores arranged by Tom Weichel and Emerson Todd. The new officers of the Section took over at the meeting as Harold B. Wickey retired as chairman. The new chairman is John S. Marshall and his fellow officers are Donald Markle, Jr., vice chairman, and John T. Griffiths, secretary-treasurer.

AIME President Howard C. Pyle (right) cheerfully presents an award pin to Floyd Saunders for securing five new members.

Retiring Chairman Harold B. Wickey (left) turns over the gavel and chair to new Section Chairman, J. S. Marshall.

Head table guests at the Pennsylvania-Anthracite Section dinner on June 24 enjoyed an evening at the Irem Temple Country Club, Dallas, Pa. Beginning at the right the guests are Ralph Lambert, Pennsylvania Dept. of Mines; Walter B. Petzold and Mrs. Petzold; Ernest Kirkendall, AIME Secretary; Mrs. and Mr. John S. Marshall, vice chairman; Mrs. Pyle and Howard C. Pyle, AIME President; Harold B. Wickey, chairman; Floyd S. Saunders, secretary-treasurer and Mrs. Saunders; Mrs. Paul Goddard; Mr. and Mrs. Edgar Kudlick, chairman of the Woman's Auxiliary; and Mr. and Mrs. John T. Griffiths, chairman of the Building Fund committee.



Coal mining has been the mainstay of West Virginia's economy and the principal source of industrial employment for many years and is predicted to be important for a long time to come. West Virginia leads all the states in the production of bituminous coal and in 1958 accounted for 29 pct of the nation's output.

With this emphasis on coal in the state's geology and economy, it is to be expected that mining education assume a prominent position in the state's planning. The School of Mines at West Virginia University was established in 1926 to meet this challenge, although mining engineering had existed as a department in the College of Engineering for many years prior to that time.

Excellent facilities and housing for the School are provided in the Mineral Industries Building with well equipped laboratories for education and research. Coal mining is given special emphasis in the mining engineering curriculum. Courses offered directly in the School of Mines are almost entirely professional; the general engineering and other subjects common to engineering curricula are intergrated with the College of Engineering and University programs.

The curricula offered are designed to provide thorough training in the engineering sciences and their application to the solution of technical and management problems encountered in the mining and petroleum industries. Broad basic training in business and the social sciences equip the graduates to develop rapidly toward assumption of the full professional, management, social, and civic responsibilities of the engineer.

Situated at Morgantown in the heart of the great Pittsburgh coal field, the campus has available some of the most modern coal mines in the nation. Through the active cooperation of the operating companies, these large mines constitute permanent laboratories for underground and surface practices. Extensive oil and natural gas fields in northern West Virginia and bordering states provide these research and instruction advantages to the petroleum and geological engineering students.

Another supplemental facility at Morgantown is the Appalachian Experiment Station of the U. S. Bureau of Mines. Through cooperative research agreements with the University, the Station provides opportunity for student participation in research projects related to coal, oil, and natural gas.

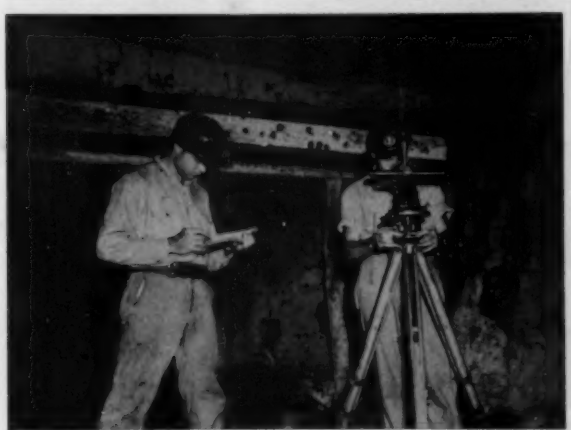
The placement record of the School has been essentially perfect for 90 pct of the graduates are employed in their field of professional specialization. During recent years the demand for young mining engineers has exceeded the supply by substantial margins.

The Student Chapter of AIME is an active campus organization and sponsors monthly meetings with guest speakers or films. Students are encouraged to affiliate with the chapter early in their academic programs to aid in the development of professional interests and familiarity with technical problems.

G. Ralph Spindler, professor at West Virginia University, has been appointed dean of the School of Mines.

In addition to its degree program at Morgantown, the School of Mines maintains a Mining and Industrial Extension Dept. to provide technical education at the vocational or noncredit level throughout the state for employes of West Virginia industries. First emphasis is given to the training and educational requirements of the mining industry but the services of the department are available to the members of any industrial group in the state and a diversified program is offered to conform with local demands.

The mining and industrial extension program has become well established through many years of operation and the instruction of thousands of industrial workers, many of whom have advanced to responsible supervisory and management positions. The program has constituted a liaison service which has permitted the School of Mines to be closely associated on a day to day basis with the industries of the state, particularly those included in the professional curricula offered—coal, oil, and natural gas.



An engineering survey party gains actual experience in one of the coal mines of the Pittsbugh Coal Field, close to the campus of the School of Mines, West Virginia University. The Mineral Industries Building, above, also offers excellent facilities for training.

Around the Sections

Members of the New York Section listen to facts about The Anaconda Wire and Cable Co., Hastings, N. Y., during their tour of the 3 million volt laboratory, May 22.

• The **Carolina Subsection of the** Southeast Section held a dinner meeting on May 29 at the Grove Park Inn, Asheville, N. C. Guest speaker was Raymond B. Ladoo who discussed *The Future For Industrial Minerals* with special emphasis on industrial minerals of the Carolinas.

• The final meeting of **Minerals Beneficiation Subsection** of the Minnesota Section for the 1958-1959 season was held at the Mesaba Country Club in Hibbing on May 27. R. A. Blackburn, manager of Strategic Materials Section, Koppers Co., was the guest speaker on the subject *Strategic-Udy Direct Reduction Process.* In his talk Mr. Blackburn presented slides of the pilot plant operation at Niagara Falls and gave estimated cost figures.

Officers elected for the 1959-1960 season were Fred H. Bunge, chairman; R. C. Ferguson, vice chairman; and R. A. Derby, secretary-treasurer.

• Pittsburgh's **Mineral Industry Group** met for dinner on March 18. J. L. Gillson, President-Elect of AIME and chief geologist of E. I. du Pont de Nemours and Co., presented an illustrated talk on the production, reserves, uses, and demand for metallurgical and acid grades of fluorspar. Dr. Gillson also discussed limestone, dolomite, bauxite, chromite, and manganese, which are important to industries operating or headquartered in the Pittsburgh area.

On May 6, 100 members attended an all-day field trip through the Aliquippa Works of J & L Steel Corp.

• At the **Knoxville Subsection,** Southeast Section, meeting on May 8 Phil Eckman, superintendent of Appalachian Sulfides Inc., gave an illustrated talk on *Operations at Ore Knob.* Appalachian Sulfides is the Southeast's newest copper mine. Wives were invited to this meeting at the Holston Hills Country Club.

• A joint dinner meeting of the **Denver Petroleum** and the **Colorado Sections** was held May 21 at the Petroleum Club in Denver. A social hour preceded the business discussion and the presentation of the Viola Vestal Coulter Award for scholastic excellence and potential in the field of engineering, awarded to Jerry Dee Richards. Then, the guest of honor, Howard C. Pyle, President of the Institute, discussed his philosophy for exploration.

The Adirondack Section Starts Summer Program

The first meeting of the active summer program of the Adirondack Section was an informative Plattsburg Air Base tour on April 25. A luncheon at the Officers Club started the activities, followed by a short presentation on the role of the Strategic Air Command. During the afternoon the visitors viewed jet bomber equipment at close range and climbed through one of the KC-97 tankers.

A cocktail hour at Dick Guibord's home preceded the formal dinner and business meeting at the Cumberland Hotel. Guest of honor was SME President-Elect A. B. Cummins, who spoke briefly on the Institute and its current activities, after the new Section officers had been introduced and results of the Section's student essay contest evaluated. Mr. Cummins discussed the fund raising drive for the Engineering Center, the plans to publish and up-to-date Mining Engineer's Handbook, and plans to make available translations of important technical papers.

This worthwhile meeting and tour were made possible through the courtesy of Col. Van Arb, Plattsburg Air Base Commander.

Program chairman of the Section, Brower Dellinger, outlined plans for future meetings. Check the Coming Events page for further data.

In the foreground left, SME President-Elect A. B. Cummins looks thoughtful as he answers a question from Adirondack Section chairman Charles F. Dievendorf. W. A. Blomstran talks things over with Dick Guibord who held a reception for the members.

In September the Minerals Beneficiation Division will participate in the American Chemical Soc. annual meeting in Atlantic City with a special Colloid Section Symposium. The symposium theme will be *Phenomena Relating to the Solid/Liquid Interface*. Conference dates are September 13 to 18, and A. Gaudin will introduce the speakers. Here is the complete program as it now stands:

Observations on Monolayers of C_{14} Labeled Stearic Acid: *George L. Gaines*, General Electric Co.

Effect of the Spreading Solvents on the Properties of Monolayers: *M. L. Robbins and V. LaMer*, Columbia University.

Static and Dynamic Attachment of Air Bubbles to Solid Surfaces: *J. Leja, John S. Carr, J. H. Schulman*, University of Alberta and Columbia University.

Recedence of Aqueous Films from Hydrophobic Surfaces: *D. W. Fuerstenau*, Kaiser Aluminum and Chemical Corp.

The Stability, Contact Angle and Surface Tension of Teflon Dispersion in Water: *W. A. Zisman and N. L. Jarvis*, Office of Naval Research Laboratory.

Reflection Infrared Studies of Films Adsorbed on Metal Surfaces from Carboxylic Acid Solutions: *A. H. Ellison and S. A. Francis*, Texaco Research Center.

Phenomena Related to Degressing of Electrodes for Electroplating: *H. B. Linford*, Columbia University, and *E. B. Saubestre*, Enthone Inc., New Haven, Conn.

Adsorption of Polymers on Solid Interfaces: *Frederick R. Eirich and G. Lopatin*, Brooklyn Polytechnic.

Structure-Sensitive Aspects of Localized Corrosion in Aluminum: *O. P. Arora and M. Metzger*, University of Illinois.

Contact Potentials at the Oil Metal Interfaces: *F. M. Fowkes*, Shell Development Co., Emeryville.

Electrochemical Theory of Interface Reactions: *Henry Eyring and Xavier de Hemptinne and Taikyue Ree*, University of Utah.

The Effect of Chelation Agents on Electrode Phenomena: *Robert N. O'Brien*, University of Alberta.

Electrode Effects in Streaming Potential Measurements: *Gordon Zucker and N. Arbiter*, Columbia University.

Electrophoretic Mobility and Charge Distribution in $BaSO_4$ Suspensions: *R. H. Smellie, Malcolm H. Forbes, and V. LaMer*, Trinity College and Columbia University.

An Electrochemical Study of the Silver Iodide Aqueous Solution System in the Presence of Sodium Laurate: *H. E. Bergna and P. L. de Bruyn*, Massachusetts Inst. of Technology.

The Adsorption of Surface Active Anions and their Gegenions to the Graphon/Solution Interface: *A. C. Zettlemoyer and J. D. Skewis*, Lehigh University.

Measurements of Heats of Wetting of Montmorillonites: *Eric Hutchinson and Douglas I. Longwell*, Stanford University.

Heats of Immersion, III, The Influence of Substrate Structure in the SiO_2-H_2O System: *W. H. Wade, R. E. Every, and N. Hackerman*, University of Texas.

Adsorption of Silicic Acid on Thoria Determined by Infrared Spectroscopy: *M. E. Wadsworth and G. J. Spaepen and R. Ted Wimber*, University of Utah.

Studies on the Surface Topography of Silica: *D. J. C. Yates*, Columbia University.

Influence of the Surface on Deformation Processes in Ceramic Materials: *Robert A. Lad*, N.A.S.A., Lewis Research Center.

The Sensitivity of the Fracture Strength of Rock Salt to Environment: *E. S. Machlin*, Columbia University.

Environmental Effects on the Brittle Fracture of Zinc Single Crystals: *Maxwell Gensamer and L. C. Weiner*, Columbia University.

Effect of Surface Active Agents on the Strength Properties of Metals: *L. Nanis and J. H. Schulman*, Columbia University.

Executive Committee of MBD Will Meet in Fall

An MBD Executive Committee Business Meeting will be held during the American Mining Congress Meeting in Denver, September 14 to 16. The time and place of this meeting will be announced later, according to MBD Chairman, Wayne L. Dowdey.

MBD Nominee

The nominee for First Regional Vice Chairman, as reported last month, is **Stephen E. Erickson.** A graduate of the University of Minnesota, he worked on the Minnesota iron ranges in various positions and spent a short period working for a gold mine in Montana before joining American Cyanamid Co. With this firm he worked for six years on the beneficiation of non-metallic minerals. Then he transferred to Jones & Laughlin Steel Corp., working in Minnesota, Michigan, and New York as plant engineer. In 1946 he joined his present firm, the M. A. Hanna Co., where he is on their staff at Hibbing, Minn.

S. E. ERICKSON

Pacific Northwest

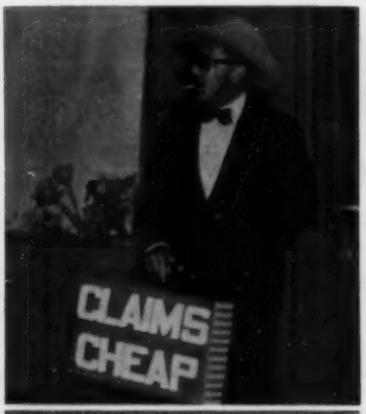
(Continued from page 825)

Poole presented his paper: *Thermodynamic Considerations in the Production of Ductile Molybdenum.* P. K. Jena and C. S. Samis discussed *Chemical Oxidation of Carbon by Lead Silicate Slags*; E. W. Cawthorne presented his paper: *Titanium 1959*; and G. W. Dunn lectured on the *Fluidity of Lead Alloys.*

In the mining session Arthur J. Theis, chairman, introduced Stephen Hathaway who discussed *Rock Alteration and Vein Mineralization at the Buffalo Mine.* The other two speakers were Gary Rice on *Sand Stope Filling at the Star Mine* and Richard Robbins who gave the paper: *New Developments in Continuous Mechanical Mining, Tunneling, and Shaft Sinking.*

The Council of Education met Friday afternoon, along with sessions on physical metallurgy and industrial minerals. John Roberts was the industrial minerals chairman, introducing speakers on the topics *The Coming Pozzalan Industry* and *Phosphate Rock Mining in Idaho.* Wolf Baur and O. E. Pothier were the speakers, consecutively.

At the luncheon the featured speaker was Howard C. Pyle, AIME President. The banquet that evening was followed by dancing in the ballroom. The women, too, enjoyed the conference, with special events of their own. Luncheon and entertainment at the Washington Athletic Club highlighted their program.



The lighter side of the symposium is caught in these candid shots at the banquet below and the floor show above. The line-up of ladies and girls displays the feminine talent involved in the successful show, and the variety of skits at the top prove the versatility of the mining men. While Elvis belts out a song and Groucho takes it on the chin, the Arthur Murrays and MC Steve Allen watch.

Uranium Symposium Features Forums, Fashions, and Floor Shows

Moab, Utah, was the site once again for the fourth annual Uranium Symposium on May 8 through 10, sponsored by the AIME Uranium Section. Technical papers; geology, mining, and milling forums; field trips, and ladies events filled three busy days.

The first highlight of the program was the welcoming luncheon on Friday. Host Charlie Steen introduced the Honorable George D. Clyde, Governor of Utah. In his address Governor Clyde emphasized the importance of keeping taxes in line so that they will "never go high enough to discourage private initiative in exploration and development of raw materials." Nevertheless, he added, the government "should receive a reasonable return from the wealth taken from its soil." This set the symposium keynote for later discussions of government and private control over the uranium industry.

After the luncheon the following papers were presented in the first session: *Ore Occurrence at the Rio De Oro Mine, Ambrosia Lake District* by R. J. Cronk; *Exploratory Drilling in Uravan Mineral Belt* by James Hastings; *Chemical Oxidants for Alkaline Leaching* by D. C. McLean; *Recent Developments at Big Buck Mine, Standard Uranium Corp.* by Russell Wood; *The Kermac Nuclear Fuel Mill at Grants* by A. V. Henrickson; and *The Role of Gamma Ray Logging in Estimation of Uranium Ore Reserves* by Ross L. Kinnamon.

In the evening a cocktail party preceded the banquet and entertainment. Before the lighter part of the program, Jess Larsen, president of Uranium Inst. of America, gave the banquet address, warning members of the domestic uranium industry of "continued austerity" under long-term government control. "The whole problem of the domestic industry is a matter of budget policy of the government monoply in uranium," he declared. A realistic outlook is needed, Mr. Larsen implied in his advice to independent operators: "I do think that the average uranium miner and miller had better get to work right now and further reduce costs and increase efficiency of operations during the next few years if he hopes to survive."

Then the gayer side of the symposium broke loose with the Las Vegas floor show at the Towne & Country Club. Clever impersonators gave lively skits under the general supervision of John Mullen and A. Karayan. Steve Allen, alias Don Robinson, acted as MC, introducing Groucho Marx (E. J. Claus), Rosalind Russell (Aurora Florence), Katherine and Arthur Murray (Margy and Maurice Brady), Hedda Hopper (Fern Mullen), Dr. Werner Von Braun and Guest (Roy F. Hollis and Steven Robinson), Elvis Presley (Jack Mayhew), Patrice Munsel (Ann Maloney), Dr. Ralph L. Finley (Ralph Stroble), plus the style show members, the movie cast, and the orchestra.

On Saturday, five papers were presented in the morning session, then the groups split for separate luncheons and three forums for geology, mining, and milling. At the luncheons Jack Ehrhorn discussed *Uranium and Research* and John E. Bailey talked about safety organization. Meanwhile the Women's Auxiliary sponsored a luncheon and fashion show for the ladies. Saturday night featured the Chuck Wagon Supper at Charles Steen's home overlooking the city, and Sunday was a family field day for sight-seeing excursions.

Informal photos above show the geology forum, left, where Robert K. Wyant was moderator, and the mining forum at right, with G. E. Roberts as moderator. Standing by the pool of his fabulous home overlooking Moab, Charles Steen is host for the symposium on Saturday night. And at the welcoming luncheon (corner picture) he introduced the Honorable George D. Clyde, Governor of Utah.

Personals

Recent promotions in the Goodman Manufacturing Co. include the appointment of **C. E. McWhorter** as manager of Mining and Product Development. He had served as manager of the Denver district, and as mining engineer, where he will be succeeded by **K. E. Caine** who had been manager of the Pittsburgh sales district. **John C. Cosgrove Jr.**, will assume managership at Pittsburgh and **L. W. Peterson** will take over where Mr. Cosgrove had been at Huntington, W. Va. The vacancy caused by Mr. Peterson's transfer will be filled by **Charles D. Reese**, formerly assistant manager at Pittsburgh.

C. E. McWHORTER

J. C. COSGROVE

Arie Poldervaart, professor of geology, Columbia University, has received a Guggenheim Fellowship for studies of the pre-Cambrian geology of certain parts of Africa and Europe.

The Dept. of the Interior bestowed the Interior's Distinguished Service Award and gold medal on Bureau of Mines director **Marling J. Ankeny** and **Earle P. Shoub**, regional director from Pittsburgh.

A team of five from Pierce Management Corp. went to Korea in May for advisory government of Korean government coal mines. **John L. G. Weysser**, vice president, will head the team with his headquarters in Seoul, and **James H. Pierce** and **John S. Marshall** will visit Korea frequently.

The U. S. Steel Foundation Inc. has announced the renewal of a doctoral fellowship for **Thomas V. Falkie**, graduate student in mining engineering at The Pennsylvania State University for the year 1959-1960. He has completed one year as a Foundation fellow, pursuing a course of study leading to a Ph.D.

Walter F. Munford, executive vice president for engineering and research, has been named president, director, and chairman of the executive committee of the U. S. Steel Corp., to succeed **Clifford F. Hood** who has retired.

C. O. REESE

K. E. CAINE

Sherwin F. Kelly has spent the last summer and winter in British Columbia where his firm, Geophysical Explorations Ltd., has been conducting geophysical surveys for the Power Commission on dam sites on Mosley Creek and a number of mineral surveys in the Merritt Nicola area of Southern British Columbia. The firm is currently engaged as geological consultants in the exploration of one property north of Merritt and in the development and bringing into production of another copper property, the Aberdeen mines, northwest of Merritt.

Garry Sainsbury, formerly a student at the University of Missouri School of Mines and Metallurgy, is a super-

PROPOSAL FOR AIME MEMBERSHIP

I consider the following person to be qualified for membership and request that a membership kit be mailed to him:

Name of Prospective Member:

.....

Address

.....

.....

.....

Name of AIME Member:

.....

Address

.....

.....

.....

SME

CHANGE OF ADDRESS AND PERSONALS FORM

CHANGING YOUR ADDRESS? Don't forget to notify us six (6) weeks before you move, if possible, to insure uninterrupted receipt of your publications and correspondence. Please fill in the form below and send it to: J. F. Lynch, Asst. Treasurer AIME, 29 West 39th Street, New York 18, N. Y.

Name .....

Old Address .....

.....

.....

New Address .....

.....

.....

PERSONALS: Please list below your former company and title and your new title and company (or new work) for use in MINING ENGINEERING. (Copy deadline for personals items is six weeks before date of issue.)

Former Company .....

Former Title ..... Length of Time There .....

New Company .....

New Title ..... Date of Change .....

.....

Any recent activity that would be of interest to members:

.....

.....

.....

visor trainee for Climax Molybdenum Co. while completing his master's thesis on *Economics of Mineral Exploration, Development, and Exploitation.*

Robert H. L. Egerton, formerly geologist with Mattagami Syndicate, now is employed by Cyprus Mines Corp. in Cyprus.

H. Marks has moved from Stone's Corner,. Queensland, to Melbourne, Victoria, Australia, to join the Yarra Constructions Pty. Ltd.

Robert A. Falconer has moved from Moab, Utah, to Darien, Conn., changing jobs from metallurgical technician for Uranium Reduction Co. to test engineer for Dorr-Oliver Inc.

Ed L. Healy, employed by the Falconbridge Nickel Mines Ltd. in Ontario, formerly was manager of the Projects Div. and now is assistant manager of production, Mining and Reduction Div.

F. W. Millsaps has moved from Grand Junction, Colo., to Lowell, Ariz., where he is now test engineer for Phelps Dodge Corp.

W. A. Green has been elected to the new position of executive vice president of Hudson Bay Mining and Smelting Co. Ltd. He has been vice president and director since 1956.

James D. Moore, former production manager, has been named plant manager at Vitro Uranium Co.'s mill in Salt Lake City .

L. W. PETERSON

B. SAMUELSON

Western-Knapp Engineering Co. of San Francisco has appointed **Bengt Samuelson** manager of the Hibbing, Minn., district. He has served as project manager overseeing the construction of numerous smelters, concentrators, and other plants.

Armine F. Banfield, of Behre Dolbear & Co., has returned to New York from Teheran after completion of a report on a mineral reconnaissance of an area of 47,000 sq mi in the Kerman region of southern Iran.

Henry E. Schoo, who was an armament systems officer in the U. S. Air Force, now is assistant engineer for Climax Molybdenum Co.

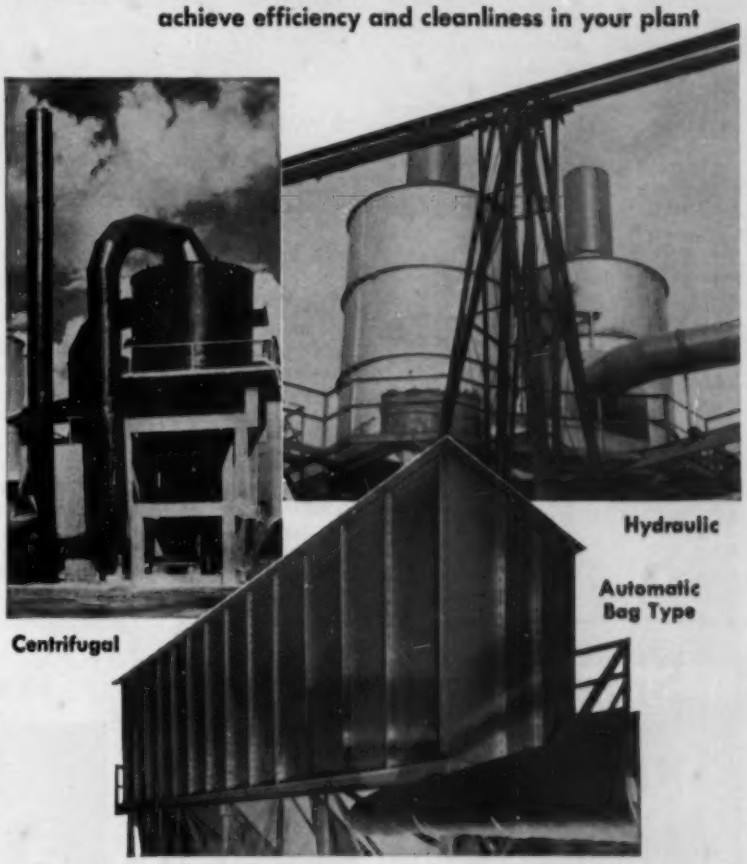
Lee Nugent, formerly a 2nd. Lieutenant in the U. S. Army, now is an engineer for Kermac Nuclear Fuels Corp.

The Strategic Minerals Div. of

Get rid of dust!

It's expensive!

Norblo Dust and Fume Collection helps you achieve efficiency and cleanliness in your plant



Any dust or fume condition can slow down employee performance, increase spoilage and industrial accidents. All of which costs money — and *increased operating and maintenance costs.* Norblo helps you to achieve outstanding efficiency in dust and fume collection — helps you to avoid these costly factors economically.

Norblo's valuable experience of almost 50 years in three principal dust collection methods is widely recognized in industry. The Norblo patented Centrifugal system is often installed in combination with the Norblo Hydraulic Collector or Norblo Bag Type Collector — the most imitated *automatic* bag type dust arrester.

High recovery with low operating and maintenance costs is the record of Norblo dust and fume collection installations. Ask your consultant, or write direct for information about Norblo *guaranteed* performance.

The Northern Blower Company

6424 Barberton Ave. • OLympic 1-1300 • Cleveland 3, Ohio

Norblo ENGINEERED DUST COLLECTION SYSTEMS FOR ALL INDUSTRIES

personals

continued

Phillips Petroleum Co. has been incorporated into the Mining and Milling Dept. and all personnel have been assigned various mining, geological, and land positions. **C. N. Holmes,** formerly director, has become assistant manager of the new department.

Roy K. Alexander has been transferred from the Lima, Peru, office of Gardner-Denver Co. to the Denver office, remaining in the position of field engineer.

Robert G. Blair of the Atomic Energy Commission transferred back to Grand Junction operations office after four years in various field offices in Wyoming, New Mexico, and Texas. He remains a geological engineer.

George R. Powe has been appointed assistant general manager of properties and industrial development for Northern Pacific Railway Co., with headquarters in St. Paul, Minn.

Evan Just, mining engineer and geologist who heads the International Drilling and Water Co. Inc., will become a professor and head the Mineral Engineering Dept. at Stanford University this fall.

L. D. GENT

R. T. HAIR

R. T. Hair has been appointed general sales manager, Coal Machinery Div., Joy Manufacturing Co., in a reorganization of the division. **Lawrence D. Gent,** former manager of the Pittsburgh district sales office, has been appointed sales manager, coal industry. **Ralph M. Hippard** will succeed Mr. Gent in his former post.

Kenneth B. Goode has left his position with Mt. Isa Mines Ltd., and has accepted a position with Waman Equipment Pg. Ltd. in Artarmon, New South Wales, Australia, as design engineer.

Monolith Companies have elected one vice president and one assistant vice president and other supervisors to strengthen the organization of the two firms. **H. D. McBride** was elected vice president. **Bert Oberg** became assistant vice president. **Duncan R. Williams** was appointed general superintendent; **Paul L. Schoonover** was appointed executive chief engineer; **Greeley H. Scott** became sales and service manager for Los Angeles and **Richard G. Hames** became his assistant; **Harold E. Potter** was made superintendent of the cement plant at Laramie, Wyo.; and **J. L. Coulthard** became his assistant superintendent.

Ernst H. Ahrens has been transferred from Quebec to Butte, Mont., with The Anaconda Co., where he will continue as a geologist.

Raymond K. Robbins, Texas Petroleum Co., has been transferred to the company's division in Bogota, Colombia, from the Lima, Peru, division.

Alan Howe, formerly mines captain for Sierra Leone Chrome Mines Co. Ltd. in British West Africa, now is technical adviser to The Ham River Grit Co. Ltd. in London. He would welcome any information on new concrete placing techniques, especially in tunnelling.

Gerald J. Ballmer has retired from his position of superintendent of mines for Kennecott Copper Corp., Chino Mines Div., after 24 years of service, and has moved to Vista, Calif.

John F. Abel, Jr., received an M.S.

Smelting on Site

with

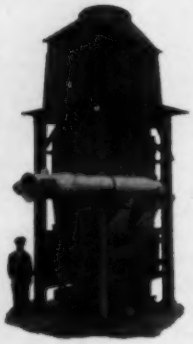
MACE Furnaces

and

Sintering Hearths

Saves high transportation and treatment charges on your ores and concentrates.

Wire or write for new catalog.



Standard sizes 5 to 250 tons capacity. Working scale tests on ton lots or larger made at our Denver smelter. Send us an analysis for preliminary report.

The Mace Company

FIRE CONCENTRATION METALLURGISTS

2759 Blake Street, Denver 5, Colo., U.S.A.

NEW, SAFE and AUTOMATIC

Mayo Mine Car Coupler

. . . the coupler with the mating instinct

Mayo's new, cast steel coupler for narrow gauge mine cars couples instantly on tangent or curves. Safe, self-centering link completely eliminates all hazards of hand couplings. Only a little more expensive than link-and-pin, it more than pays for itself by preventing accidents. If you can save one smashed finger, you've got these couplers paid for. Easily installed by bolting to existing cars. Write for Bulletin No. 21.

MAYO

TUNNEL & MINE EQUIPMENT

LANCASTER, PA.

Steel Forms
Headframes
Muck Bins
Shields-Airlocks
Locomotives
Mine Cars
Grouters

from the Colorado School of Mines and returned to his position as mining engineer for the U. S. Army Snow Ice and Permafrost Research Establishment in Evanston, Ill.

Richard F. Moe, formerly manager of mines for Kermac Nuclear Fuels Corp., has become manager of the Church Rock mine for Phillips Petroleum Co. Phillips is engaged in exploration and mining in the Gallup, N. M., area.

W. E. Bales, geological engineer for the U. S. Atomic Energy Commission, who has been in the Div. of Raw Materials for the past three years, now is in the Grants, N. M., Branch, Production Evaluation Div. after a year of evaluating uranium deposits in southeastern Oregon.

Walter A. Tallon, who has been an economic geologist for West Virginia Geological Survey, now is a geologist for H. K. Porter Co. Inc., doing raw material exploration and procurement in Pittsburgh.

R. M. HIPPARD

H. F. HEBLEY

Henry F. Hebley retired last December from his position as research consultant for Consolidation Coal Co. after an association with the firm of almost 20 years. He plans to do consulting work on problems of stream and air pollution as they concern the coal industry.

Martin S. Tischler, formerly mine engineer, Nickel Processing Corp., has accepted the position of field geologist with Southern Pacific Co., Land Dept., in University City, Mo.

Thomas H. Bird has left Cia. Auxiliar de Empresas de Mineracao where he was geologist, for the job of photo interpreter for Ramo-Wooldridge Inc. in Van Nuys, Calif.

Grant Metzger has been moved to the city offices of Calaveras Cement Co., San Francisco, and was elected vice president of production.

James T. Orsborn has gone into partnership in Arrowhead Geoservices, doing geological consulting and property development work. Presently the firm is interested in mineral developments in the Southeast. Mr. Osborn had been with Pickands Mather and Co., Duluth, Minn.

William Kodrowsky, U. S. Steel Corp., who had been senior industrial engineer in the Frick district, now is district industrial engineer in the Lynch district.

Hardinge Rod Mill awaiting shipment to the Marquette Iron Range to grind iron ore in a flotation plant.

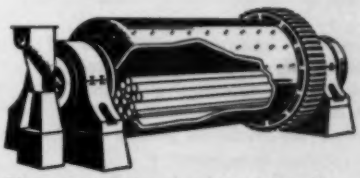
Hardinge ROD MILLS

Sizes range from 2' to 11½' shell diameter and up to 1000 horsepower.

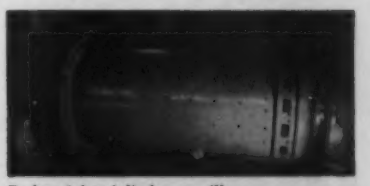
Types include trunnion overflow and peripheral discharge for both wet and dry grinding.

Applications include both open and closed circuit arrangements for ores, aggregates, concrete sand, cokes, and abrasives.

Complete specifications on request. Ask for Bulletin 25-C-2.

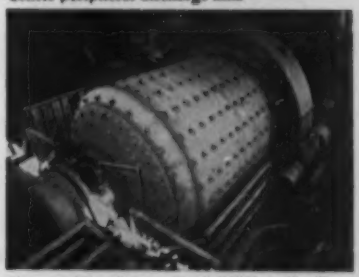


The conical head of the Hardinge Rod Mill provides a feed pocket to allow the charge to enter the rods without over-loading or choking.



End peripheral discharge mill

Center peripheral discharge mill



Large Hardinge Rod Mill, grinding lead-zinc ore.

HARDINGE

COMPANY, INCORPORATED

YORK, PENNSYLVANIA • 240 ARCH ST. • Main Office and Works

New York • Toronto • Chicago • Hibbing • Houston • Salt Lake City • San Francisco • Birmingham • Jacksonville Beach

personals

continued

O. S. STRAUS

I. N. BAYLESS

I. N. Bayless, who rose from miner to president of Union Pacific Coal Co., has retired from this position, to be succeeded by **V. O. Murray,** former general manager of the company, with headquarters in Rock Springs, Wyo.

Oscar S. Straus became a partner in the firm of Guggenheim Brothers on May 1, 1959, and will be in charge of new projects, exploration, and development. He resigned as chairman of the Finance Committee of American Smelting and Refining Co., but will continue as a director.

C. Steven Lekowski, formerly chief of party of Kennecott Copper Co., Chino Mines Div., has become mining engineer for National Gypsum Co. in Kimballton, Va.

Ellis C. Helge, now a mine engineer at the Peterson mine of Puritan Mining Co., had been foreman for Eire Mining Co. This was an inter company transfer within Pickands Mather & Co., managing agents. He is now located in Ramsay, Mich.

Jim Papike, formerly a student at South Dakota School of Mines, now is a graduate student at the University of Minnesota.

William E. Rudolph has retired after 11 years with Chile Exploration Co. as chief engineer in Chuquicamata, Chile. Now he is in consulting practice with Dorr Associates Inc.

Serge A. Berkovich, formerly director of research, Technical Service Laboratories, in Toronto, now is manager of Freeman Corp., in Trois Rivieres, Quebec.

Charles B. Belt, Jr., is now a geologist with The Anaconda Co. in Butte, Mont. He had been assistant geologist for Mineracao Hannaco.

Fred Scharf, formerly mine engineer, Magnet Cove Barium Corp., now works for York Mining Industries in Danville, Ky.

Howard C. Pyle, AIME President and president of Monterey Oil Co., received an honorary doctorate from the Colorado School of Mines. Dr. Pyle delivered the Commencement address and was awarded the engineering degree by John W. Vanderwilt (background), the president.

Hubert W. Norman, formerly manager of mining and exploration for Daybreak Uranium Inc., now is senior geologist for Federal-Radorock-Gas Hills Partners in Riverton, Wyo. **Raymond G. Lindlof,** formerly chief engineer for Federal Uranium Corp., has also joined the firm.

H. I. Altshuler, vice president and consulting engineer for the New York and Honduras Rosario Mining Co., has returned to the U. S. after an extensive professional trip to Peru, Chile, and Central America.

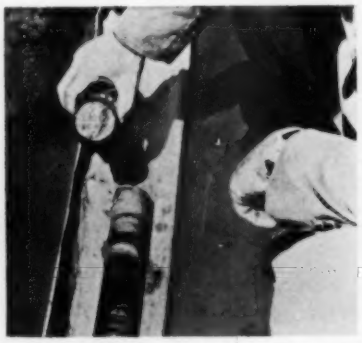
At the April board meeting of the American Smelting and Refining Co., **Robert D. Bradford** was elected executive vice president and **Charles F. Barber** and **Forrest G. Hamrick** were elected vice presidents. Mr. Bradford is president of Lake Asbestos of Quebec Ltd., Asarco subsidiary. Mr. Barber came to Asarco in 1956 as general counsel. Forrest Hamrick was elected treasurer and director in 1957.

Oscar Pearson has been named administrative vice president of the steel producing divisions and **E. H. Gott** became administrative vice president, central operations of steel and coal, for U. S. Steel Corp.

Boyd E. Cass has been named general sales manager of Foote Mineral Co. He had served as manager of metallurgical sales. **Anthony C. Demos,** formerly sales engineer, succeeds Mr. Cass in his former position.

R. C. Bryant, formerly geologist for Miami Copper Co., is initiating an evaluation and exploration program in Honduras for United Fruit Co. He is exploration geologist for Tela Railroad Co.

98% CORE RECOVERY IN UNCONSOLIDATED SAND & SILTSTONE!



In the Gas Hills Area of Wyoming, loose sand and siltstone occur in the ore-bearing zone with core recovery averaging about 65%. In our determination to give only the very best, Sprague & Henwood used the "frozen" core technique by which the recovery was increased to 98%.

The value of ore reserves can best be determined by a high percentage of core recovery. Throughout Sprague & Henwood's more than 75 years of service to the industry, we have consistently made every effort to furnish the highest percentage of core possible. Our new contract brochure illustrates our complete drilling service; we would be glad to send you a copy upon request.

If you are planning a program of diamond drilling, from either the surface or from underground, contact Sprague & Henwood, Inc., at our home office in Scranton, Pennsylvania, or at the branch nearest you.

SPRAGUE & HENWOOD, Inc.
SCRANTON 2, PA.

S&H SINCE 1863

New York—Philadelphia—Atlanta—Pittsburgh—Grand Junction, Colo.—Buchans, Nfld.

O. G. Seymour has recently accepted a position as senior geologist with Marcona Mining Co. at San Juan, Peru. He had been senior geologist for the M. A. Hanna Co. in Iron River, Mich.

Thomas M. Waterland, formerly junior engineer for Dominion Wabana Ore Div. in Wabana, Newfoundland, now works for Geco Mines Ltd. in Ontario.

Warren R. Wagner, geological consultant, spent March, April, and May as visiting professor at the Dept. of Geology, Florida State University, Tallahassee, Fla.

M. L. Fitzgerald, formerly concentrator superintendent for Bancroft Mines Ltd., now is manager of research and instrumentation divisions of Rhoanglo Mines Services Ltd.

R. B. Tempest completed his Air Force Inst. of Technology training at the University of Wyoming, received a Master of Industrial Management degree and is now at Anderson Air Force Base, Guam, for a career in the installation engineering field.

William E. Mead, who had been in Tanganyika for Uruwira Minerals Ltd., now is geologist with Hudson Laboratories of Columbia University.

Wilfred A. Lyons has been engaged in special geological work on behalf of the Corporacion Minera de Bolivia in the Animas and San Jose mines for the last six months, and now is chief geologist in the Empresa Minera Colquiri, north of Oruro, Bolivia.

P. ARNOLD

R. CHELMINSKI

Peter Arnold has been promoted to the sales engineering staff of Hanson-Van Winkle-Munning Co. He has been associated with the company as consulting engineer and a specialist in automation and material handling in the Engineering Dept.

Roman Chelminski has joined Singmaster & Breyer as an associate. He had previously been a senior partner of Knowles Associates for 12 years.

Ian G. McColl, who has been a research assistant in the mining department of the University of Melbourne, now is junior research metallurgist for Peko Mines No Liability, in the Northern Territory, Australia.

A. M. Scheier has left Atlas Consolidated Mining & Development Corp. where he was mill superintendent in Cebu City, Philippines, and has joined Phelps Dodge Corp.

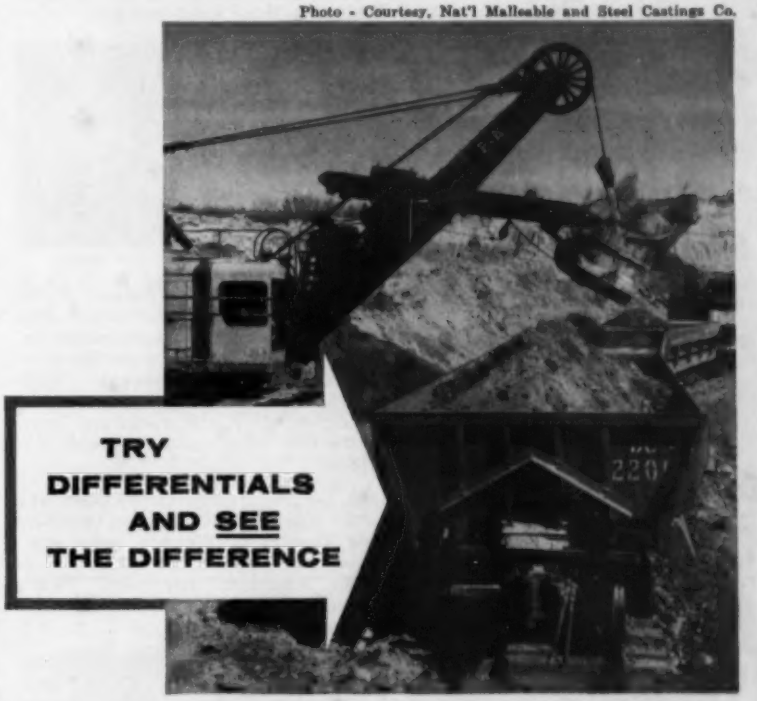
D. W. Mitchell, an employe of Foote Mineral Co., has transferred from Kings Mountain, N. C. where he was manager of minerals research, to Berwyn, Pa., where he is coordinator, research and production, and manager of minerals research.

Two University of Utah College of Mines alumni were awarded professional degrees in June. **Charles E. Bartlett,** manager of operations in British Guiana for Reynolds Metals Co., and **Clark L. Wilson,** vice president and manager of operations of New Park Mining Co. received degrees in metallurgical and geological engineering, respectively.

Bernard Barlin has transferred from Bancroft Mines Ltd. where he was assistant concl. superintendent, to Nchanga Consolidated Copper Mines, an inter-group transfer. He is still in Northern Rhodesia.

Keith O'Donnell, assistant manager of Sedren, S. A., subsidiary of Halliwell of Canada, was presented with the Haitian decoration "Ordre National du Travail", chevalier class, at a ceremony held in Gonaives on

Photo - Courtesy, Nat'l Malleable and Steel Castings Co.



It takes a tough car to take it away, day after day. The many tons of heavy iron ore that fall relentlessly from the shovel demand a car that can take it.

Differential side dump cars — air powered — have been serving the industry for some decades, now, and their performance brings back steady repeat orders that speak for themselves.

Let us send you complete specifications and discuss your needs at your convenience. You'll like what you hear about Differentials.

PIONEERS IN HAULAGE EQUIPMENT SINCE 1915

DIFFERENTIAL STEEL CAR COMPANY
FINDLAY, OHIO

Boyles Bros. DRILLING COMPANY

GENERAL OFFICES:
Salt Lake City, Utah — HUnter 7-7595

BRANCHES:
Phoenix, Arizona — CRestwood 4-5331
Sacramento, California — IVanhoe 3-5221
Denver, Colorado — Alpine 5-9244
Boise, Idaho — 3-7152
Reno, Nevada — FAirview 9-0732
Spokane, Washington — WAlnut 4-2614
Alaska — Contact Salt Lake City Office

personals

continued

May 18, 1959. Sedren S. A. is currently preparing its copper property in the Terre Nueve district of Haiti.

L. H. Lange, vice president of The Galigher Co., Salt Lake City, has been on a two-month consulting trip in the Philippines for Atlas Consolidated Mining & Development Corp. He returned to the U. S. in May via Hong Kong and Tokyo.

M. J. KENNARD

A. P. KRAGE

Max J. Kennard, manager of the Engineering and Construction Div. of Southwestern Engineering Co., Los Angeles, has been elected vice-president of the company with responsibility for administration, purchasing, engineering and construction functions for varied projects.

In the April 1959 issue, page 441, "the piper leader" has been identified as **Thomas G. Stewart,** sales engineer for Western Machinery Co. in San Francisco. His alert friends wrote to the Editor asking for his recognition.

August P. Krage, district sales manager for Universal Engineering-Hammermills Inc., has been transferred to industrial sales and has his office in Dallas for the southwestern area.

Walter R. Hibbard, Jr., of General Electric Research Laboratory, has been presented with the 1959 Yale Engineering Assn. Award for the Advancement of Basic and Applied Science.

Two professional degrees were awarded by the Montana School of Mines to **Wallace A. O'Brien** and **Clinton L. Miller.** Mr. O'Brien is mines geologist for The Anaconda Co. in the Butte area. Mr. Miller is general superintendent of a mine owned by Compania Minera, Aguilar, Argentina. They received, respectively, the degree of geological engineer and engineer of mines.

L. S. Breckon, chief of the land division of Bear Creek Mining Co., exploration subsidiary of Kennecott, retired in June following more than 40 years in the mining industry. A native of Salt Lake City, Mr. Breckon plans to do consulting work in geology, mining, and land problems.

George W. Tower of Tower and Bowers, mining consultants, has returned from professional visits to Morocco, Spain, and Ireland. Mr. Tower was formerly general manager of mines for Hochschild interests in South America.

New officers of Moa Bay Mining Co., subsidiary of Freeport Nickel Co., are **Richard V. Colligan,** president and director; **Balfour F. Darnell,** vice president and general manager; **Robert L. James,** vice president; **Rudolph E. Kruger,** vice president, finance; and **Daniel W. Machon,** vice president, administrative.

Distinguished Achievement Medals were awarded to five Colorado School of Mines alumni on May 22. The award winners were: **George W. Clarke,** vice president, Pan American Petroleum Corp.; **Kuno Doerr, Jr.,** president, Southern Peru Copper Corp.; **Theodore Marvin,** president, Michigan Chemical Corp.; **Robert S. Stockton,** retired superintendent of operation, Canadian Pacific Railroad; and **Robert R. Williams, Jr.,** manager of mines, Colorado Fuel and Iron Corp.

Samuel R. Parry, formerly vice president and general manager of the Chattanooga Div. of Combustion Engineering Inc., has been appointed vice president in charge of manufacturing for the entire company.

Robert T. Edgar has been appointed Div. vice president in charge of production, U. S. Borax & Chemical Corp. He will have overall supervision of the Pacific Coast Borax Co. plants. Formerly Mr. Edgar was manager of manufacturing with Ethyl Corp. of Canada.

W. L. Wearly, left president of Joy Manufacturing Co., was awarded an honorary Doctor of Engineering degree by Purdue University. F. L. Hovde, right Purdue president, conferred the special degree.

Obituaries

John H. Eggers (Member 1940) died Jan. 9, 1959. His many years of mining experience extended back to hand mining during the summers at Sheep Trail mine, Arizona, and laborer on Yuba Dredgers for Palmer & McBride, while attending the University of California. He received his B.S. in 1909 and became mill superintendent for Cia de Los Reyes in Jalisco, Mexico. He had many supervisory positions in the following years, for Golden Eagle mine, Virginia Mine, etc., then was occupied in examinations of chrome, quicksilver, and oil properties. In 1939 he was vice president and engineer in charge of operations of the Bondurant Mining & Milling Co.

Morris J. Elsing (Member 1913) died on Feb. 27, 1959. Mr. Elsing was born in Berlin in 1883 but was brought to the U. S. when six weeks old and grew up to attend Columbia University School of Mines where he graduated in 1907. He became chief geologist for Phelps Dodge Corp., Copper Queen mine at Bisbee, Ariz., and in 1910 joined Cananea Consolidated Copper Co. in Mexico as chief geologist and mine superintendent. He returned to Bisbee in 1918 to open a consulting office. Ten years later he set up an office in Tucson. He also spent three years in Japan and Manchuria and was with the War Production Board in Washington, D. C.

Edward G. Gray (Member 1939) recently passed away. He had been born in 1904 in North Carolina, and attended the Newport News Shipbuilding and Dry Dock Company's Apprentice Academy from 1920 to 1924. Then he went to Los Angeles as a mechanical draftsman. He worked for Shell Co. of California doing structural steel and plant layout design, joined Fluor Corp. in Los Angeles, and later Howes & Whitaker Construction Engineering. In 1939 he was with Goldfield Consolidated Mines Co. in San Francisco.

John Knox (Member 1917), born in Kilwinning, Scotland in 1876, has passed away. He was educated at Michigan College of Mines, receiving an E.M. degree there in 1899, and spent most of his mining career in Michigan and Ontario. After several positions as engineer, he became underground superintendent of Conglomerate mine for Calument & Hecla Mining Co. He was promoted to general superintendent of the firm, then joined Hollinger Consolidated Gold Mines, Ltd., as general manager.

Keith Kunze (Member 1946), mill superintendent for Getchell Mines Inc., Golconda, Nev., died Dec. 29, 1958. He was born in 1911 in Bishop, Calif., and moved with his family to Mountain View, Calif., where he was educated. His mining career included jobs with Central Eureka Mining Co., the Newmont Mining Corp., U. S. Vanadium, Empire Star Mines Co., plus mining jobs in the mother lode district near Hornitos, Calif. He was the author of numerous mining and metallurgy articles, and became a Captain in the U. S. Army.

James E. Moore (Member 1925), retired mining engineer, died Dec. 7, 1958. He was born in Colorado, educated at the University of Nevada, Mackay School of Mines, receiving his B.S. there in 1909, and spent several years in Mexico and the Philippines. He was manager of Mexican Candelaria Mining Co., general manager of Gold River Mining Co. in Baguio, P. I., and manager for the Lucky Tiger-Combination Gold Mining Co. in Nevada and Colorado.

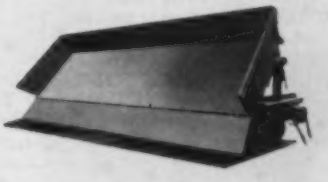
Joseph A. Norden (Member 1925) died on Jan. 7, 1959. He was born in Chicago in 1893 and attended Lane Technical School there. He worked for Utah Apex Mining Co. in Bingham Canyon, Utah, in various capacities, rising from mucker to assistant superintendent, and finally superintendent in 1920. He also was a consulting engineer, and lived in Placerville, Calif.

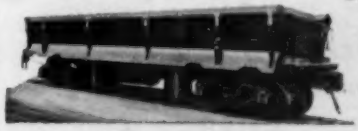
MAGOR AIR DUMP CARS

FOR THE MINING INDUSTRY

FEWER TRIPS

Safe side dumping eliminates expensive labor and crane equipment. Completely smooth interiors permit full dumping—no "dead load" returns!





LOWER HEIGHT, OPEN BODY

Lower height, and open body means faster loading. Quick, smooth dumping action means faster unloading—saves time and labor costs.

DESIGNED FOR THE JOB

Magor Air Dump Cars are designed for the job—built to last! Actual performance records prove cost of replacement parts furnished by Magor equals less than 1/10 of 1% of the purchase price per car, per year!

Write today for details of America's leading Automatic Air Dump Car!

MAGOR CAR CORPORATION

30 Church Street
New York 7, N.Y.

Cecil Henry Desch

WHEREAS, with the death of Cecil Henry Desch on June 19, 1958, the American Institute of Mining, Metallurgical, and Petroleum Engineers lost one of its most distinguished members, and

WHEREAS, Dr. Desch was awarded Honorary Membership in the Institute in 1946 in recognition of his contributions to the science of metallurgy, particularly during his long and brilliant direction of the work of the National Physical Laboratory, and

WHEREAS, through his publications, particularly, "Metallography", and his lectures, he has won an outstanding, international reputation,

THEREFORE, BE IT RESOLVED, that the American Institute of Mining, Metallurgical, and Petroleum Engineers record its sorrow over the loss of this eminent member of our profession, and

BE IT FURTHER RESOLVED, that this Resolution be spread upon the Minutes of this Meeting and a copy sent to the family of Cecil Henry Desch.

June 23, 1959

Charles Camsell

Memorial Resolution Prepared by *Norman B. Davis*

WHEREAS with the death of Charles Camsell in Ottawa on December 19, 1958, the American Institute of Mining, Metallurgical, and Petroleum Engineers has lost one of its most distinguished Canadian members, and

WHEREAS, during his thirty-three years of membership, he served as a Director of the Institute from 1939 to 1945, and was awarded Honorary Membership in 1946, and

WHEREAS, for almost half a century he devoted himself to furthering the development of the tremendous potentialities of the Canadian Northwest Territories, and

WHEREAS, he won national and international recognition in the fields of exploration and geology and distinguished himself in the public service of Canada,

THEREFORE, BE IT RESOLVED that the American Institute of Mining, Metallurgical, and Petroleum Engineers record its sorrow over the loss of this outstanding member of our profession, and

BE IT FURTHER RESOLVED that this Resolution be spread upon the Minutes of this meeting, and a copy sent to Mrs. Camsell.

June 23, 1959

Eugene McAuliffe

Memorial Resolution Prepared by *I. N. Bayless*

WHEREAS, with the passing of Eugene McAuliffe on June 2, 1959, the Institute lost a staunch friend and loyal supporter; and

WHEREAS, during his lifetime of varied and colorful experiences, he was ever devoted to progress in the mining industry, and particularly, at all times, extended a helping hand to young engineers; and

WHEREAS, during his career he was the author of a number of books, papers, and articles on the subject of coal mining and handling, always stressing safety in conjunction with efficiency; and for distinguished engineering and executive service in coal mining, was invested with an Honorary Degree of Doctor of Engineering by the Missouri School of Mines, and

WHEREAS, having joined AIME in 1909, he was always active and willing to serve. He was a Director from 1929 to 1933, and from 1943 to 1945; a Vice President from 1933 to 1935; President in 1942; recipient of the Erskine Ramsay Gold Medal in 1949; and elected to the Legion of Honor of the Institute in 1959;

THERFORE, BE IT RESOLVED, the American Institute of Mining, Metallurgical, and Petroleum Engineers records with deep sorrow the loss of this distinguished member and friend; and

BE IT FURTHER RESOLVED, that this Resolution be spread upon the Minutes of this meeting and a copy be sent to Mrs. McAuliffe.

June 23, 1959

Eugene McAuliffe

An Appreciation By
I. N. Bayless

On June 2, 1959, the mining industry and engineering profession lost a staunch friend and faithful worker with the death, at age 92, of Eugene McAuliffe (Legion of Honor Member 1909) at his home in Omaha, Neb. Throughout the coal mining fraternity, the name of McAuliffe came to mean a warm friend and a dedicated man.

To a few intimate friends and members of his family he was "Gene"; to myself and others closely associated with him in industry he was often called "Mr. Mac"; but more generally, to friends and acquaintances, he was always "Mr. McAuliffe."

Mr. McAuliffe was born Oct. 3, 1866, son of an army staff officer, at Maidstone, Kent, England. The boy, Eugene, at the age of six, came with his parents to Canada. The following year they settled at Fargo in Dakota Territory, where he continued his private and public school education, begun in Toronto, and later carried on at Moorhead, Minn.

At the age of 20 he started work as a shop apprentice for Northern Pacific. For the next 15 years McAuliffe went into locomotive service on railroads in the U. S. and Mexico.

In 1903 Mr. McAuliffe took the position of fuel agent with the Frisco railroad, and thereafter was always engaged in some capacity in coal mining and distribution. In 1908 he was made president of the Brazil Block Coal Co., operating in Illinois and Indiana. Later he entered the service of the North American Co., a public utility holding company, as vice president of the West Kentucky Coal Co., general manager of the Wayne Mining Co. of Ohio, and president and general manager of the Union Colliery Co. in Illinois. During World War I Mr. McAuliffe was appointed manager of the fuel conservation section of the U.S. Railroad Administration, with offices in many key cities throughout the eastern and central states.

On March 1, 1923, he was elected president of the Union Pacific Coal Co. and other subsidiaries of the railroad on the recommendation of its president, Carl R. Gray. Although I had known Mr. Mac for many years prior to that time, I only became closely associated with him when I, in turn, came to the Union Pacific properties in October 1929.

Mr. McAuliffe always joined in the promotion of safety in the mines, as well as various community welfare projects for the benefit of the workmen and their families. He wrote a number of books, papers, and articles on coal mining and distribution. In 1927 the Missouri School of Mines conferred on him the honorary degree of Doctor of Engineering.

He joined the AIME in 1909; was a director from 1929 to 1933, and from 1943 to 1945; was Vice President from 1933 to 1935; served as President in 1942; and was elected to the Legion of Honor in 1959. In 1949 he was the recipient of the Erskine Ramsay Gold Medal. Mr. Mac always enjoyed attending the meetings of the Institute, and serving on its various committees. He was an Honorary Member of the British Institution of Mining Engineers.

In 1944 Mr. McAuliffe was elected chairman of the board of the Union Pacific Coal Co., and retired in 1947. After his retirement, in addition to keeping abreast of progress in the industry, his interest centered on promoting the erection of a statue for posterity of his boyhood idol, Gen. George Custer. This, it is understood, was on the way to fulfillment at the time of his death.

Mr. McAuliffe is survived by his wife and a daughter, Kathleen, of Omaha, and another daughter, Mrs. Mary Tucker, of Kansas City, Mo.

Necrology

Date Elected	Name	Date of Death
1944	Gideon A. Apell	Apr. 27, 1959
1929	Worthen Bradley	Unknown
1920	Charles A. Breitung	Apr. 8, 1958
1956	Viggo Harms	May 27, 1959
1913	Frank H. Hayes	Mar. 29, 1959
1930	Clifford Hoag	Apr. 30, 1959
1912	Tadashiro Inouye	Mar. 18, 1959
1953	William M. Keay	Mar. 19, 1959
1940	Malcolm B. Kildale	June 13, 1959
1917	Milton S. Lindholm	June 12, 1959
1939	Henning Marstrander	Mar. 31, 1959
1950	Jon S. Mayer	May 30, 1959
1909	Eugene McAuliffe Legion of Honor	June 2, 1959
1946	Henry B. Parfet	May 29, 1959
1916	Chester H. Steele	May 19, 1959
1920	Andrew W. Tolonen	Apr. 11, 1959
1920	Charles W. Wheelock	May 30, 1959
1945	Sheldon V. Wood	May 31, 1959

Membership

Proposed for Membership Society of Mining Engineers of AIME

Total AIME membership on May 31, 1959, was 32,024; in addition 2,582 Student Members were enrolled.

ADMISSIONS COMMITTEE

A. E. Weissenborn, Chairman; Frank A. Ayer, Vice Chairman; R. T. Lassiter, Charles H. Lambur, Alfred D. Rood, William J. Rude, L. P. Warriner.

The Institute desires to extend its privileges to every person to whom it can be of service, but does not desire as members persons who are unqualified. Institute members are urged to review this list as soon as possible and immediately to inform the Secretary's office if names of people are found who are known to be unqualified for AIME membership.

Members

O. Jalmer Anderson, Ishpeming, Mich.
Vernon J. Bishop, Uravan, Colo.
Gordon L. Blackburn, Hamilton, Mont.
Calvin S. Boland, Toronto
Mario J. de Bastiani, Spragge, Ont., Canada
Donald W. Dixon, Ajo, Ariz.
Nicholas P. Esteban, Idria, Calif.
Helmut Hoffman, Valencia, Venezuela
Herman H. Huestis, Whiterock, B.C., Canada
Generoso C. Lazaga, Manila, P.I.
Edmund W. Littlefield, San Francisco
Robert L. Lund, Zortman, Mont.
Virgil I. Mann, Chapel Hill, N.C.
Arthur G. Matherly, Puerto Ordaz, Venezuela
Elwood Meschter, Jr., Chicago
George H. Morel, Chicago Heights, Ill.
Melvin A. Neff, Bethlehem, Pa.
Francisco B. Perez Aguilar, Mexico City
William H. Svigel, Taconite, Minn.
Alan C. Teasdale, New South Wales, Australia
Isacov H. Vered-Weiss, Telaviv, Isreal
Charles F. Withington, Washington, D.C.

Associate Members

Heber C. Brimley, Salt Lake City
Andrew E. Burnett, Birmingham
Richard L. Cooney, New York
Edward H. Eisenbrey, Tucson, Ariz.
Herbert E. Heymaker, Sierra Madre, Calif.
Kenneth R. Herrmann, Aravda, Colo.
John J. Kampmeyer, Minneapolis
Elvis J. Stahr, Jr., Morgantown, W. Va.
Archie C. Wood, Gabbs, Nev.

Junior Members

Bernard G. Fisk, Kabundi, Northern Rhodesia
Arthur M. Heyman, Berkeley Heights, N.J.
Ralph S. Mattson, Rancagua, Chile
Sammie E. McLaughlin, Plant City, Fla.

REINSTATEMENTS

Member

Fred E. Butcher, Danville, Ill.
Norman C. Croome, Calgary, Ont., Canada
Byron N. Egan, Lexington, Ky.

REINSTATEMENT—CHANGE OF STATUS

Associate to Member

James F. Olk, Tucson, Ariz.

Junior to Member

Vernon N. Cox, Jamaica, B.W.I.
Robert L. Meyer, Fresnillo, Mexico

Junior to Associate

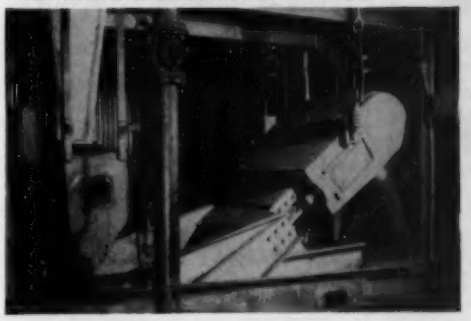
Donald A. Hall, Allentown, Pa.

Student to Member

Kay P. Sutton, Scottsdale, Ariz.

SYNTRON

VIBRATING SCREENS



SCREENING FEEDER

for efficient, dependable low cost scalping, sizing, dewatering or fine screening

PULSATING MAGNET SCREENS

SYNTRON builds a vibrating screen for every screening job from heavy duty scalping to fine screening of coal and ores.

SYNTRON Vibrating Screens are built in a variety of styles —one, two or three deck models with drive units designed for each particular screen. Available in sizes ranging from 2 feet wide x 5 feet long to 6 feet wide x 14 feet long plus the 4 feet wide x 20 feet long conveyor screen.

SYNTRON Screens provide uniform vibration, eliminating dead spots. Constant full screen efficiency provides more effective separation and higher capacity.

SYNTRON Screens combine efficiency, dependability and low maintenance to give better separation, greater tonnage at lower cost.

SYNTRON Screens are compact, easy to install, easy to maintain.

GRIZZLY BAR SCREENS

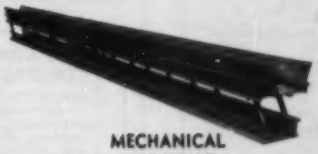
Write for complete information on all SYNTRON Screens.

SYNTRON COMPANY

554 Lexington Ave. Homer City, Pa.

Other SYNTRON Equipment of proven dependable Quality

SELENIUM OR SILICON RECTIFIER POWER UNITS



MECHANICAL VIBRATING CONVEYORS

CAR RAPPERS

PROFESSIONAL SERVICES

Listing Instructions

Space limited to AIME members or to companies that have at least one member on their staffs. One inch, $50 per year; half inch, $30 per year, payable in advance.

Alabama

COWIN & COMPANY, INC.
Mining Engineers and Contractors
Shaft & Slope Sinking • Mine Development
Mine Plant Construction
1-18th Street SW.
Birmingham, Ala. Phone 56-3566

KIRK & COWIN, INC.
RALPH E. KIRK PERCY G. COWIN
Mining Consultants and Engineers
One 18th St., S. W., Birmingham 11, Ala.
Phone: STate 6-5566

Alaska

ALASKA MINERAL CONSULTANTS
P.O. Box 3686 Phone 69867
(airmail)
Anchorage, Alaska

WILLIAM A. O'NEILL
Registered
Consulting Mining Engineer-Geologist
Exploration-Valuation-Management
Anchorage, Alaska
Phone 47671 P.O. Box 2000

Arizona

THEODORE A. DODGE
Consulting Mining Geologist
635 North Third Ave. Tucson, Arizona

HEINRICHS GEOEXPLORATION CO.
Mining Oil, Water Consultants & Contractors
MOBILE MAGNETOMETER SURVEYS
Geophysics Geology Geochem & Evaluations
Box 5671, Tucson, Ariz. PH: MA 2-4202

JAMES A. HOAGLAND
Consulting Mining Geologist
635 North Third Ave. Tucson, Arizona

THORP D. SAWYER
Consulting Engineer
Mining & Water Project Investigations, Appraisals, Etc.
601 Valley National Bldg.
Tel. MAin 4-3726 Tucson, Arizona

CHARLES P. SEEL
Mining Geology
Examinations in Mexico
635 North Third Ave. Tucson, Ariz.

STILL & STILL
Consulting Mining Engineers and Geologists
24 Union Block — Phone 658
P.O. Box 1512
Prescott, Arizona

Arkansas

RAPHAEL G. KAZMANN
Consulting Ground-Water Engineer
Stuttgart, Arkansas

California

FAIRCHILD AERIAL SURVEYS, INC.
Airborne Magnetometer & Gradiometer Surveys, Topographic Mapping, Aerial Photography, and Photographic Mosaics for Mining Exploration.
224 E. 11th St. Los Angeles
30 Rockefeller Plaza New York

FRANCIS H. FREDERICK
Consulting Mining Geologist
690 Market Street
San Francisco 4, California
Telephone: Sutter 1-1562

ABBOT A. HANKS, INC.
ASSAYERS-CHEMISTS
SPECTROGRAPHERS
SHIPPERS REPRESENTATIVES
1300 Sansome Street
San Francisco 11, California
EXbrook 7-2464

WARREN L. HOWES
Consultant
Mining & Metallurgical Plants
Research, design, construction, operations
Project Management
Estimates—Appraisals
1305 Hillview Dr., Menlo Park, Calif.
Tel. DAvenport 5-7752

CARLTON D. HULIN
Mining Geology
7 Ardilla Road Orinda, California

JACOBS ASSOCIATES
Consulting Construction Engineers
Specialists in tunnel and shaft work — Estimates — Methods Analyses — Engineering Geology — Designers of hoisting, haulage, materials handling and reduction plants.
503 Market Street, San Francisco 5, Calif.

KELLOGG EXPLORATION COMPANY
Geologists-Geophysicists
Air, Ground Surveys and Interpretation
3301 No. Marengo, Altadena, Calif.
Sycamore 4-1973

CLAYTON T. McNEIL, E. M.
Consulting Mining Engineer
822 Bank of America Bldg.
Tel. GArfield 1-2948
SAN FRANCISCO 4, CALIFORNIA

ASSAYS—Complete, accurate, guaranteed. Highest quality spectrographic. Only $5 per sample.
REED ENGINEERING
620-AB So. Inglewood Ave.
Inglewood 1, Calif.

Colorado

BALL ASSOCIATES
Oil, Gas and Minerals Consultants
Douglas Ball S. Power Warren
Offices
C. A. Johnson Bldg. Denver, Colo. ALpine 5-4878
1025 Vermont Ave. Washington, D. C. STerling 3-1929

O. W. WALVOORD CO.
Mill-Design and Construction
401 High St. Denver 3, Colo.

Connecticut

JOHN F. MYERS
Consulting Beneficiation Engineer
2 Putnam Hill
Greenwich, Conn.

GODFREY B. WALKER
Metallurgical Consultant
Mineral Dressing & Extractive Metallurgy
Heavy Media a Specialty
33 Bellwood Road, Old Greenwich, Conn.

District of Columbia

JOHN D. MORGAN, JR., E. M., PH. D.
Consultant
Business and Defense Problems in Metals, Minerals, and Fuels
1001 Connecticut Ave., N.W.
Washington 6, D. C.
ME 8-1681

APPRAISALS • CONSTRUCTION • GEOLOGISTS
ASSAYERS • CONSULTING • GEOPHYSICISTS
CHEMIST • DRILLING • MANAGEMENT
METALLURGICAL • REPORTS • VALUATIONS

CLOYD M. SMITH
Mining Engineer
Mine Examinations
Ventilation Surveys
Munsey Building Washington 4, D.C.

Florida

HARRY B. CANNON ASSOCIATES
Geologists — Engineers
Exploration Ore Dressing
Specialists in Heavy Minerals
P.O. Box 2432 Lakeland, Florida

ALLEN T. COLE and ASSOCIATES
Consultants — Industrial Minerals
Phosphate, Barite, Heavy Minerals, Industrial Sands
2815 Cleveland Heights Blvd.
Lakeland, Florida
MUtual 9-9351 MUtual 3-9033

Georgia

BLANDFORD C. BURGESS
Registered Professional Engineer
Mining Consultant
Monticello, Georgia

Idaho

6526 Holiday Drive Phone
Boise, Idaho 4-1925
WARREN R. WAGNER
Geologist
Serving the Mining, Chemical and Construction Industries

Illinois

ALLEN & GARCIA COMPANY
47 Years' Service to the Coal and Salt Industries as Consultants, Constructing Engineers and Managers
Authoritative Reports and Appraisals
332 S. MICHIGAN AVE., CHICAGO
120 WALL ST., NEW YORK CITY

JOHN F. MEISSNER ENGINEERS, INC.
Consulting Engineers
Conveyor Systems Storage Methods
Crushing Plants Ship Loading Docks
Materials Handling and Processing Plants
308 W. Washington St. Chicago 6, Ill.

PAUL WEIR CO., INC.
Established in 1936
MINING ENGINEERS & GEOLOGISTS
DESIGN & CONSTRUCTION
INDUSTRIAL ENGINEERING
20 N. WACKER DR. • CHICAGO 6, ILL.

Indiana

DIAMOND CORE DRILLING BY CONTRACT
and world's largest manufacturer
Core and grout hole drilling in coal, metal, and non-metallic deposits, both surface and underground.
JOY MANUFACTURING CO.
Contract Core Drill Division
Michigan City, Indiana

Kansas

DAVID LeCOUNT EVANS
Consultant
Mining Geology Petroleum Geology
314 Brown Bldg. Wichita, Kansas
Tel.: AMherst 2-8934 or MUrray 3-6437

Kentucky

JAMES M. DANIEL — JAMES J. LEWIS AND ASSOCIATES
Civil and Mining Engineering Consultants
United States and Foreign
860 Porter Place Lexington, Ky.

Maine

G. F. COOPE
Mining Engineer
BLUE HILL, MAINE

Massachusetts

RAYMOND B. LADOO
Consulting Engineer—Industrial Minerals
Deposit Location, Exploration, Process Design, Marketing, Economics, Percentage Depletion.
42 Huntington Road Newton 58, Mass.
Phone: (Boston) LAsell 7-1471

H. L. TALBOT
Consulting Metallurgical Engineer
Extraction and Refining of Base Metals
Specializing in Cobalt and Copper
Room 911, 209 Washington Street
Boston 8, Mass.

Continued on Page 846

DIRECTORY OF PROFESSIONAL SERVICES

Alaska Mineral Consultants ..... Alaska
Allen & Garcia Company ..... Illinois
Anderson, E. C. ..... New Mexico
Ball Associates ..... Colorado
Barr, James A. ..... Tennessee
Bateman, J. D. ..... Canada
B. B. R. Drilling Co. ..... Ohio
Behre Dolbear & Company ..... New York
Booth Co., Inc. ..... Utah
Burgess, Blandford C. ..... Georgia
Cannon Associates, Harry B. ..... Florida
Centennial Development Co. ..... Utah
Cole and Associates, Allen T. ..... Florida
Coope, G. F. ..... Maine
Cowin & Company, Inc. ..... Alabama
Daniel, James M. ..... Kentucky
Dodge, Theodore A. ..... Arizona
Eavenson, Auchmuty & Greenwald ..... Pennsylvania
Evans, David LeCount ..... Kansas
Fairchild Aerial Surveys, Inc. ..... California
Frederick, Francis H. ..... California
Geraghty, Miller & Hickok ..... New York
Gerow, Theron G. ..... Illinois
Graff Engineering Company ..... Pennsylvania
Hanks, Inc., Abbot A. ..... California
Heinrichs Geoexploration Company ..... Arizona
Hoagland, James A. ..... Arizona
Howes, Warren L. ..... California
Hulin, Carlton D. ..... California
Ingersoll, Guy E. ..... Texas
Jacobs Associates ..... California
Jones, Philip L. ..... Missouri
Joy Manufacturing Co. ..... Indiana
Kazmann, Raphael G. ..... Arkansas
Keegel, C. P. ..... Nevada
Kellogg Exploration Company ..... California
Kirk & Cowin ..... Alabama
Ladoo, Raymond B. ..... Massachusetts
Ledoux & Company ..... New Jersey
Leggette, Brashears & Graham ..... New York
Leland, George R. ..... New Mexico
Longyear Company, E. J. ..... Minnesota
Loofbourow, R. L. ..... Minnesota
Lottridge-Thomas & Associates ..... Utah
Mathews Engineering Co., Abe W. ..... Minnesota
Maye, Robert S. ..... Pennsylvania
McClintock, R. S. ..... Washington
McNeil, Clayton T. ..... California
Meissner Engineers, Inc., John F. ..... Illinois
Miller, Inc., Arnold H. ..... New York
Moos, Stanley M. ..... Mexico
Morgan, Jr., John D. ..... District of Columbia
Morrow, J. B. ..... Pennsylvania
Mott Core Drilling Co. ..... West Virginia
Myers, John P. ..... Connecticut
O'Donnell & Schmidt ..... New York
O'Neill, William A. ..... Alaska
Pearse, H. A. ..... New York
Pennsylvania Drilling Company ..... Pennsylvania
Peugnet, Amedee A. ..... Missouri
Pickering, H. M. ..... Minnesota
Pierce, Roger V. ..... Utah
Pitkin, Inc., Lucius ..... New York
Reed Engineering ..... California
Sawyer, Thorp D. ..... Arizona
Schoenike, Howard G. ..... Texas
Seel, Charles P. ..... Arizona
Sharpstone, David C. ..... So. Rhodesia
Shedwick, Jr., William J. ..... Mexico
Shenon and Full ..... Utah
Smerchanski, M. G. ..... Canada
Smith, Cloyd M. ..... District of Columbia
Sprague & Henwood, Inc. ..... Pennsylvania
Still & Still ..... Arizona
Talbot, H. L. ..... Massachusetts
Thoenen, J. R. ..... Tennessee
Thomas, Conrad Ward ..... Texas
Wagner, Warren R. ..... Idaho
Walker, Godfrey B. ..... Connecticut
Walvoord Co., O. W. ..... Colorado
Weir Company, Paul ..... Illinois
Wolf, Harry J. ..... New York
Woomer & Associates, J. W. ..... Pennsylvania
Wyser, D. C. ..... New York

See pages 846 and 847

PROFESSIONAL SERVICES CONTINUED

For other items,

see

pages 844 and 845

Minnesota

THERON G. GEROW
MINING CONSULTANT AND ENGINEER
3033 Excelsior Blvd.
Minneapolis 16, Minn.
Telephone: Walnut 2-8828

E. J. LONGYEAR CO.
Geological and Mining Consultants
Photogeology
76 South 8th Street ..... Minneapolis, Minn.
Graybar Bldg. ..... New York 17, N. Y.
Colorado Bldg. ..... Denver 2, Colo.
Shoreham Bldg. ..... Wash. 5, D. C.
77 York Street ..... Toronto, Ont.
129 Ave. de Champs-Elysees ..... Paris, France
Zeekant 35 ..... The Hague, Holland

R. L. LOOFBOUROW Min. Engr.
Site Testing — Plans — Estimates
Underground Construction — Mining
Mine Water Problems
4032 Queen Ave. So. Minneapolis 10, Minn.

ABE W. MATHEWS ENGINEERING CO.
Iron Ore Concentration Plants
Materials Handling Systems
Design and/or Construction
Hibbing Minnesota

H. M. PICKERING
Registered Professional Engineer
Mining Consultant
Truck Haulage & Crushing Plants
302 E. 22nd, Hibbing, Minn. AM 3-5153

Missouri

PHILIP L. JONES
Consultant
Mineral Economics & Mineral Dressing
Heavy Media Specialist
405 Miners Bank Bldg. Joplin, Mo.
Tel. MAyfair 3-7161

AMEDEE A. PEUGNET
CONSULTING MINING ENGINEER
Telephone MAIN 1-1431
705 Chestnut St. St. Louis 1, Mo.

Nevada

C. P. KEEGEL
Mining and Metallurgical Engineer
Administration Appraisal
1721 So. 14th St., Las Vegas, Nevada
Telephone DUdley 4-0981

New Jersey

LEDOUX & COMPANY
Chemists Assayers Spectroscopists
SHIPPERS REPRESENTATIVES
Mine Examination Analyses
359 Alfred Ave. Teaneck, New Jersey

New Mexico

EUGENE CARTER ANDERSON
Mining Engineer—Geologist
Examination—Development—Production
Socorro, New Mexico
P. O. Box 642 Tel. 159

GEORGE R. LELAND
Registered by written examination
Mining Engineer & Geologist
U.S.A. and Latin America
P.O. Box 4146 Albuquerque, N.M.

New York

BEHRE DOLBEAR & COMPANY, INC.
Geological, Mining and Metallurgical Consultants
11 Broadway New York 4, N. Y.

GERAGHTY, MILLER & HICKOK
Consulting Ground-Water Geologists
Evaluation of Ground-Water Supplies
Recommendations for the Solution of Ground-Water Problems
110 East 42nd St. New York 17, N. Y.

LEGGETTE, BRASHEARS & GRAHAM
Consulting Ground-Water Geologists
Water Supply — Salt Water Problems
Dewatering — Investigations
Recharging — Reports
551 Fifth Avenue, New York 17, N. Y.

ARNOLD H. MILLER INC.
Consulting Engineer
Mine, Mill and Industrial Investigations
Improvement Design and Recommendations
Cable: "ALMIL" Tel. Cortlandt 7-0635
120 Broadway New York 5, N. Y.

O'DONNELL & SCHMIDT
Mining Consultants
165 Broadway Tel. BArclay 7-6960
New York 6, N. Y. Cables: EXAMIMINES

H. A. PEARSE
Metallurgical Consultant
Minerals Beneficiation and Extraction of Non-Ferrous Metals
19 Pokahee Dr., North Tarrytown, N. Y.
Phone ME 1-0810

LUCIUS PITKIN, INC.
Mineralogists
Assayers—Chemists—Spectroscopists
Shippers' Representatives
PITKIN BLDG., 47 FULTON ST., NEW YORK
Cable Address: Niktip

HARRY J. WOLF
Mining and Consulting Engineer
Examinations—Valuations—Management
3 Glenwood St., Little Neck 63, N. Y.
Cable: MINEWOLF Tel. HUnter 2-7848

DAVIDSON CHARLTON WYSOR
Geologist and Sales Engineer
Fifty Church St.
New York 7, N. Y. Digby 9-3137

Ohio

B. B. R. DRILLING CO.
National Road West
St. Clairsville, Ohio
Diamond Core Drilling Contractors
Mineral Cores Guaranteed — Foundation Testing

Pennsylvania

EAVENSON, AUCHMUTY & GREENWALD
MINING ENGINEERS
Mine Operation Consultants
Coal Property Valuations
2320 Koppers Bldg. Pittsburgh 19, Pa.

GRAFF ENGINEERING COMPANY
Mining Engineers and Surveyors
39 E. Campbell St. Blairsville, Pa.

ROBERT S. MAYO
Civil Engineer Lancaster, Pa.
Specializing in Concrete Lining of Tunnels, Haulageways and Shafts. Special Equipment for Subaqueous Construction.

J. B. MORROW
COAL CONSULTANT
Oliver Bldg. Pittsburgh, Pa.

PENNSYLVANIA DRILLING COMPANY
Subsurface Explorations. Grouting Industrial Water Supply. Mineral Prospecting Large Diameter Drilled Shafts. Reports
1205 Chartiers Ave., Pittsburgh 20, Pa.

SPRAGUE & HENWOOD, Inc.
SCRANTON 2, PA.
Diamond Drill Contractors and Manufacturers
Core borings for testing mineral deposits in any part of the world.

J. W. WOOMER & ASSOCIATES
Consulting Mining Engineers
Modern Mining Systems and Designs
Foreign and Domestic Mining Reports
Henry W. Oliver Bldg., Pittsburgh, Pa.

Tennessee

JAMES A. BARR
Consulting Engineer
Mt. Pleasant, Tennessee

J. R. THOENEN
Consulting Mining Engineer
Sanford Day Road
Concord, Tennessee

Texas

GUY E. INGERSOLL
Registered Professional Engineer in Texas, Arizona and New Mexico
Mine Examinations and Geological Reports
5505 Timberwolf Drive El Paso, Texas

HOWARD G. SCHOENIKE
Consulting Mining Geologist
Examination—Evaluation—Exploration
Metallic and Nonmetallic Minerals
Domestic—Foreign
4039 Turnberry Cir.
Tel.: MO 3-7079 Houston, Texas

CONRAD WARD THOMAS
Registered Professional Engineer
COMPLETE MINING CONSULTING U.S. & FOREIGN
Bank of the Southwest Bldg., Houston, Texas

Utah

BOOTH COMPANY, INC.
Metallurgical & Chemical Engineers
Research and Consulting
Complete Laboratory
Plant Operation and Testing
333 W. 14th So. St.
Salt Lake City 15, Utah

CENTENNIAL DEVELOPMENT CO.
Consulting Mining Engineers and Contractors
Shaft Sinking — Tunnel Driving
Mine Development
Eureka, Utah Phone 560

LOTTRIDGE-THOMAS & ASSOCIATES
Professional Engineers
705 Judge Building
SALT LAKE CITY 11, UTAH

PRODUCTION AND MANAGEMENT SPECIALIST
ROGER V. PIERCE
Underground Mining Methods, Cost Cutting Surveys—Production Analysis —Mine Mechanization—Mine Management.
808 Newhouse Bldg. EMPIRE 3-5378
Salt Lake City 4, Utah

SHENON AND FULL
Consulting Mining Geologists
1351 South 2200 East
Salt Lake City 8, Utah
Telephone HUnter 4-7251
Philip J. Shenon Roy P. Full

Washington

Spokane, Wash. — Globe, Ariz.
DIAMOND CORE DRILL CONTRACTORS
Diamond Bits — Drilling Accessories
R. S. McCLINTOCK DIAMOND DRILL CO.

West Virginia

DIAMOND CORE DRILLING CONTRACTORS
Testing Mineral Deposits
Foundation Borings
MOTT CORE DRILLING CO.
Huntington, W. Va.

Canada

J. D. BATEMAN
Consulting Geologist
80 Richmond St. W.
Toronto 1, Canada EMpire 4-3182

M. G. SMERCHANSKI
Consulting Mining Geologist
Registered Professional Engineer
411 Childs Bldg. Winnipeg, Manitoba.
Phone: Whitehall 2-6323

Mexico

STANLEY M. MOOS
Mining Engineer
SPECIALIST IN MEXICO AND CENTRAL AMERICA
Mine Examinations • Mill Design
Economic Surveys • Feasibility Reports
Apartado 215 Mexico, D.F.
Cables "MOOS" Tel: 46-67-97

WILLIAM J. SHEDWICK, JR.
Mine and Geologic Reports
Mexico and Latin America
New Jersey License 2744-a
P. De La Reforma 20-304 Mexico 1, D.F.

Southern Rhodesia

DAVID C. SHARPSTONE
MINING ENGINEER and GEOLOGIST
Bulawayo So. Rhodesia
Private Bag : T 199 Cables : Minexams

Advertisers Index

Allis-Chalmers ..... *
Bert S. Gittins Adv., Inc.

Allis-Chalmers 761, 768
Klau-Van Pietersom Dunlap, Inc.

American Brattice Cloth Corp. ..... *
Tri-State Adv., Co., Inc.

American Cyanamid Co. ..... *
James J. McMahon, Inc.

American Manganese Steel Div. American Brake Shoe Co. 782, 783
Griswold-Eshleman Co.

American Steel Foundries ..... *
Erwin Wasey, Ruthrauff & Ryan, Inc.

Anaconda Co., The ..... *
Kenyon & Eckhardt, Inc.

ASEA Electric Co. ..... *
Mann-Ellis, Inc.

Atlas Copco ..... *
John Mather Lupton Co. Inc.

Bixby-Zimmer Engineering Co. ..... *
Arbingast, Becht and Assoc., Inc.

Boyles Bros. Drilling Co. 840
W. S. Adamson & Assoc.

Brunner & Lay, Inc. ..... *
Norman P. Hewitt Adv.

Bucyrus-Erie Co. 760, 826
Bert S. Gittins Adv.

Carrier Conveyor Corp. ..... *
Doe-Anderson Adv.

Caterpillar Tractor Co. 766
N. W. Ayer & Sons, Inc.

Chain Belt Co. 757, 759
The Buchen Co.

Colorado Fuel & Iron Corp., The 774
Doyle, Kitchen & McCormick, Inc.

Deister Concentrator Co., Inc. 823
Louis B. Wade, Inc.

Denver Equipment Co. ..... Third Cover
Galen E. Broyles Co., Inc.

Differential Steel Car Co. 839
Blaco Adv. Agency

Dorr-Oliver Inc. ..... *
G. M. Basford Co.

Eimco Corp., The 779
Matzie Co.

Equipment Engineers, Inc. 784
Norton M. Jacobs Adv.

Ferro Corp., Porcelain Div. 822
Downing Industrial Adv., Inc.

Ford Motor Co. 754, 755
J. Walter Thompson, Inc.

Galigher Co., The 763
W. S. Adamson & Assoc.

Gardner-Denver Co. 788
The Buchen Co.

Gruendler Crusher & Pulverizer Co. ..... *
Christy Humburg Adv.

Hardinge Co., Inc. 837
Adams Associates, Inc.

Hercules Powder Co. (Explosives) ..... *
Fuller & Smith & Ross, Inc.

Humphreys Engineering Co. ..... *
Ed M. Hunter & Co.

Infilco Inc. ..... *
Willard G. Gregory & Co.

Ingersoll-Rand Co. ..... *
Beaumont, Heller & Sperling, Inc. Marsteller, Rickard, Gebhardt & Reed Inc.

International Harvester Co. ..... *
Aubrey, Finlay, Marley, & Hodgson, Inc.

International Nickel Co., The 770
Marschalk & Pratt

Jeffrey Mfg. Co. ..... *
The Griswold-Eshleman Co.

Joy Mfg. Co. 778, 824
Erwin Wasey, Ruthrauff & Ryan Inc., Walker Div.

Kennedy Van Saun Mfg. & Engrg. Corp. 785
Robert S. Kampmann Jr.

KW-Dart Truck Co. ..... *
Carl Lawson Adv.

Longyear Co., E. J. ..... *
Pidgeon Savage & Lewis, Inc.

Marion Power Shovel Co. ..... *
The Jay H. Maish Co.

Mace Co. 836

Machinery Center Inc. ..... *
W. S. Adamson and Assoc.

Mager Car Corp. 841
Bauer Advertising

Mayo Tunnel & Mine Equipment 836
The Godfrey Agency

Michigan Chemical Corp. ..... *
Wesley Aves & Associates

Mine & Smelter Supply Co. 786
Walter L. Schump, Adv.

Mine Saftey Appliances Co. ..... Fourth Cover
Ketchum, MacLeod & Grove, Inc.

Nagle Pumps, Inc. ..... *
Tri-State Adv. Co., Inc.

National Iron Co. ..... *
H. E. Westmoreland, Inc.

National Malleable & Steel Castings Co. ..... *
Palm & Patterson Inc.

Naylor Pipe Co. ..... *
Fred H. Eversold, Inc.

Nordberg Mfg. Co. 776, 777
Russell T. Gray, Inc.

Northern Blower Co. 835
Carr Liggett Adv., Inc.

Oldsmobile Div. General Motors Corp. 775
D. P. Brother & Co.

Phelps Dodge Refining Corp. ..... *
The House of J. Hayden Twiss, Inc.

Sanford-Day Iron Works, Inc. ..... *
Charles S. Kane Co.

Sheffield Div. ARMCO Steel Corp. ..... *
Potts · Woodbury, Inc.

Smidth & Co., F. L. ..... *
The Stuart Co.

Spencer Chemical Co. ..... *
Bruce B. Brewer & Co.

Sprague & Henwood, Inc. 838
Anthracite Adv.

Stearns-Roger Mfg. Co. ..... *
Mosher-Reimer-Williamson Adv. Agency, Inc.

Syntron Co. 843
Servad, Inc.

Texas Gulf Sulphur Co. ..... *
Sanger-Funnell, Inc.

Traylor Engrg. & Mfg. Co. 773
Ritter-Lieberman, Inc.

Tyler Co., W. S. 825
The Griswold-Eshleman Co.

Vulcan Iron Works ..... *
Mosher-Reimer-Williamson Adv. Agency Inc.

Western-Knapp Engineering Co. ..... *
Westcott-Frye & Assoc.

Western Machinery Co. 769
Westcott-Frye & Assoc.

Wheel Truing Tool Co. ..... *
Clark & Bobertz, Inc.

Wiley & Sons, Inc., A. R. ..... Second Cover
Ed M. Hunter & Co.

Wilkinson Process Rubber Co., Ltd., The ..... *
Greenlys Ltd.

* Previous Issues

NOW... EVEN LARGER DENVER TURBINE PROPELLER AGITATORS

For Effective Propeller Agitation in Tanks as Large as 50' Diameter

Design of DENVER turbine type propeller makes possible large diameter propeller agitators for agitating large volumes of pulp in large tanks. One large diameter agitator handles volume of several small ones—saves space, operating expense, supervision, maintenance.

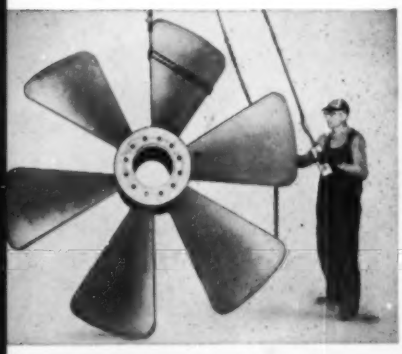
- Large diameter propeller operating at low speeds gives proper agitation with heavy slurries even as coarse as 10 mesh. Slower speeds mean savings in horsepower and further savings from reduced wear.
- Propeller is designed for long service. High mechanical efficiency moves pulp with minimum of turbulence—blades wear evenly and uniformly with no cavitation.
- Large diameter DENVER turbine type propeller eliminates problems often encountered with airlift or rake agitators—cuts need for operating attention, saves on maintenance.

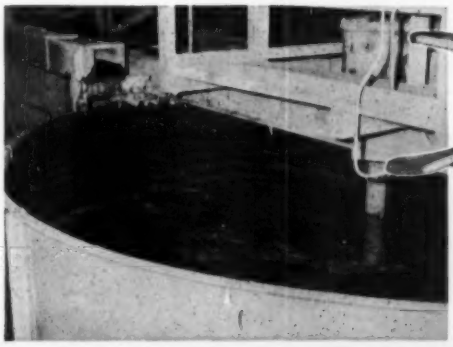
Find out how large diameter DENVER Turbine Propeller Agitators can save you money—build your profits. Send details of your requirements for careful, detailed recommendation on the correct agitator for your operation.

Leading Suppliers of Agitators for:

AGITATION
SCRUBBING
MINE BACKFILL AGITATION
PRECIPITATION
REPULPING
SLURRY HOLDING
MIXING
CONDITIONING
LEACHING
ADSORPTION
NEUTRALIZING
SOLVENT EXTRACTION

WRITE FOR BULLETIN NO. A2-86





96" diameter DENVER Propeller Agitator on Test Rack at DENVER Factory, to be used in 20' diameter by 25' deep tank.

"The firm that makes its friends happier, healthier and wealthier"

DECO — DENVER EQUIPMENT 24 HOUR SERVICE COMPANY

Complete Mill Equipment

DENVER EQUIPMENT COMPANY

1400 Seventeenth St. • Denver 17, Colorado

• DENVER
• NEW YORK
• TORONTO
• VANCOUVER
• MEXICO, D.F.
• LONDON
• JOHANNESBURG
• LIMA

Boosts haulage efficiency and increases safety...

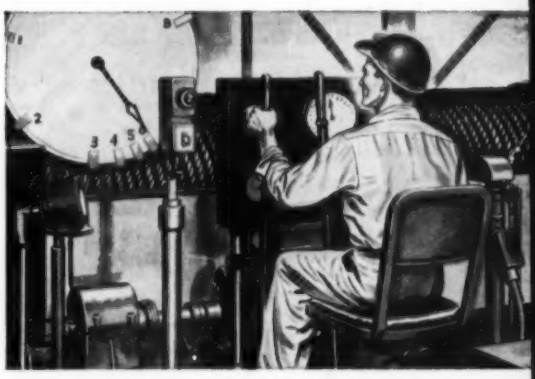
M·S·A MinePhone

The M.S.A. MinePhone is eliminating communication delays in mines everywhere. This clear, instant two-way voice communication system coordinates the wide variety of operations vital to peak production. Haulage moves faster because dispatcher and motormen are constantly in touch, even while trips are in motion. Shop and maintenance personnel are always "on call." And because messages are relayed instantly, on an open-line hookup, underground safety is increased. Write for details.

Assures accurate, safe, speedy hoisting operations...

M·S·A HoistPhone

The M.S.A. HoistPhone provides continuous, dependable and efficient voice communication between hoisting engineer and cage, at any level, and when in motion. The system is invaluable in emergencies, yet designed for day-in-day-out service. Ideal for passenger travel, load leveling, inspection trips, and construction work, the HoistPhone requires no special training; utilizes existing wiring. Write for complete details.



Permits emergency or temporary communications...

M·S·A Portable HoistPhone

A compact, integral unit that can be set up anywhere, and put into immediate service for clear, dependable voice communications. Its light weight and ease of operation make it ideal for temporary communications for inspection work or for emergency assignments. Write for details.

MSA
SAFETY EQUIPMENT HEADQUARTERS

When you have a safety problem, M.S.A. is at your service. Our job is to help you.

MINE SAFETY APPLIANCES COMPANY
201 North Braddock Avenue, Pittsburgh 8, Pa.
At Your Service: 77 branch offices in the United States and Mexico

MINE SAFETY APPLIANCES CO. OF CANADA, LTD.
Toronto, Montreal, Calgary, Edmonton, Winnipeg, Vancouver, Sydney, N.S.